TECHNOLOGY DEPARTMENT

PETROLEUM PROCESSING

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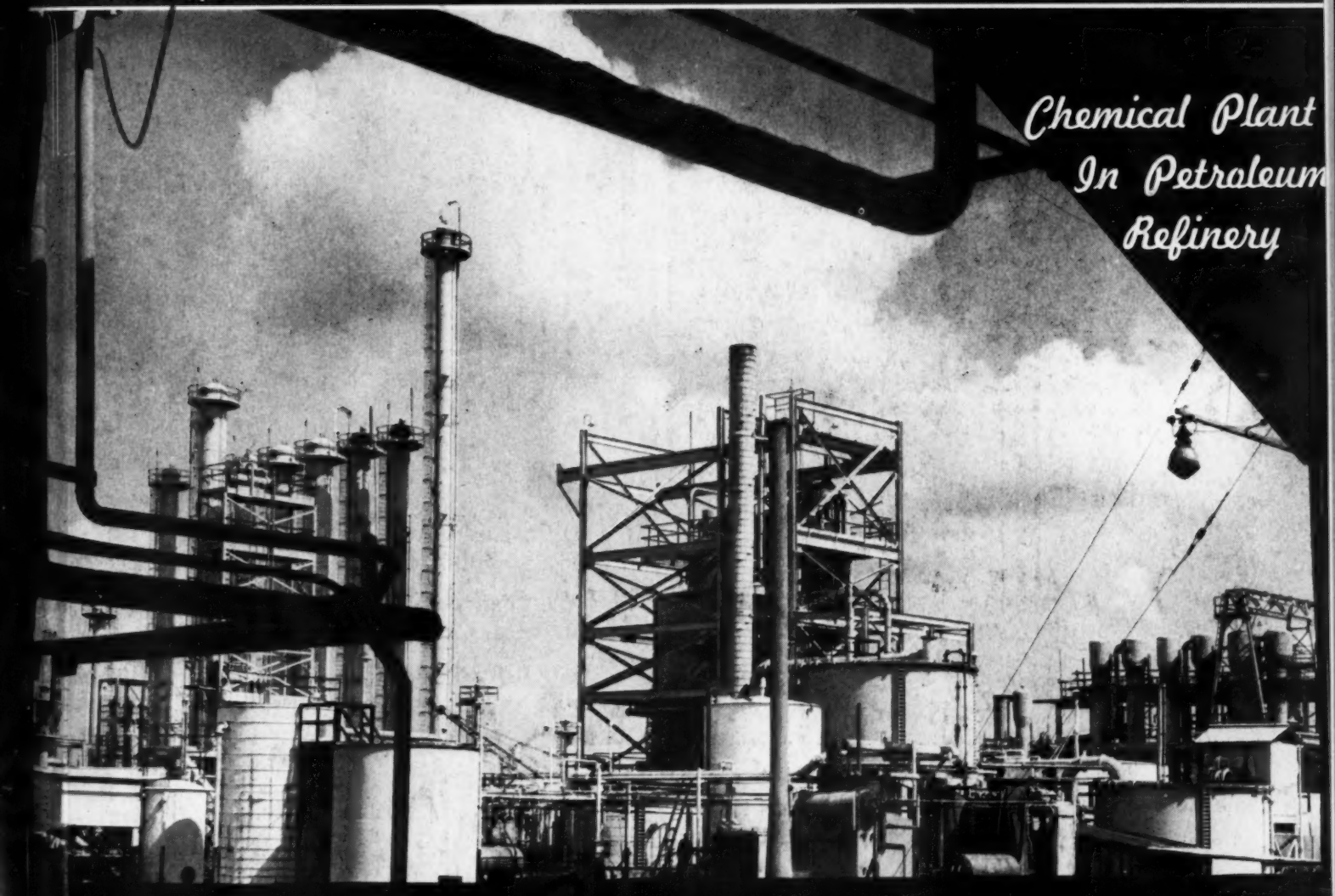
VOLUME 2, NUMBER 9 SEPTEMBER, 1947



Chemical Plant In Petroleum Refinery

FORMERLY MONTHLY TECHNICAL SECTION OF NATIONAL PETROLEUM NEWS

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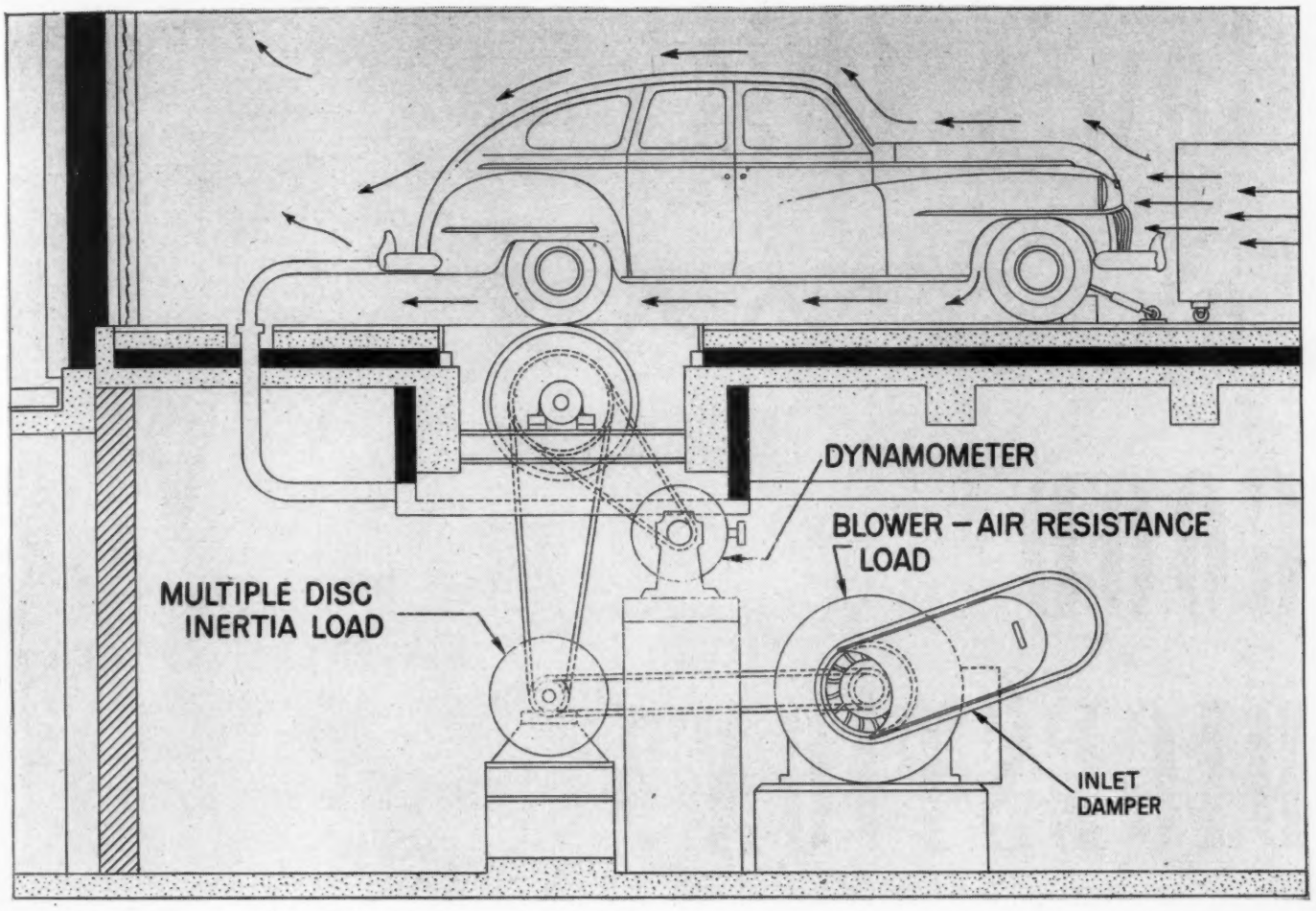

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Road knock ratings of automotive fuels may now be obtained on the rolls of a chassis dynamometer provided with special auxiliary equipment developed by the Ethyl Laboratories. The knock rating of fuels on the road—the final yardstick of antiknock performance—requires a series of full-throttle accelerations, and these must be reproduced if road ratings are to be duplicated indoors.

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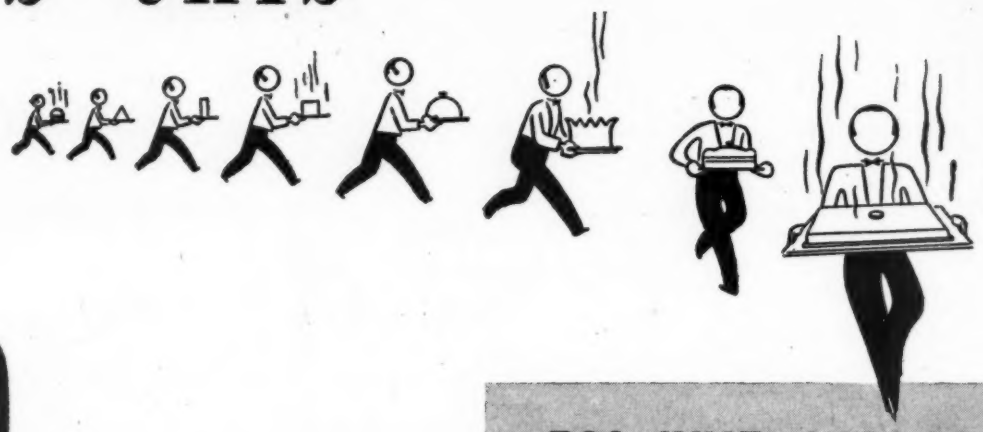

TCC UNIT CHARGES 8 DIFFERENT STOCKS ON 8 SUCCESSIVE DAYS!

The remarkable flexibility of the TCC process is well illustrated by the following record from the daily log sheets of a TCC plant:

Date	CHARGE TO TCC PLANT CONTAINED:			
	Full Crude	*Reduced Crude*	*Virgin Gas Oil*	*Kerosene*
June 7	—	—	100%	—
8	—	—	75%	25%
9	—	—	—	100%
10	25%	50%	25%	—
11	70%	—	30%	—
12	50%	—	30%	20%
13	50%	30%	—	20%
14	50%	50%	—	—

Only a Houdry-licensed catalytic cracking unit could possibly accommodate such frequent changes of charge stock without shutdown and consequent considerable (and costly) loss of production. In the case of the TCC unit reported above, no major reduction in throughput, or in output of catalytic gasoline, resulted from the daily and drastic variations in feed charge.

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VOLUME 2
NUMBER 9
SEPTEMBER, 1947
PUBLISHED
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for September, 1947

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OFFICE: 1213 West 3rd St., Cleveland 13, Ohio, telephone CHerry 7672; Editorial Bureaus—50 West 50th St., New York 20, N. Y.; 1034 National Press Bldg., Washington 4, D. C.; 59 East Van Buren St., Chicago 5, Ill.; 904 World Bldg., Tulsa 3, Okla.

Published monthly by The National Petroleum Publishing Co., 1213 West 3rd St., Cleveland 13, Ohio. Publication date—first Tuesday of each month. Subscription rate, $3.00 a year in United States and its possessions. $3.50 a year elsewhere. Single issues, 35 cents per copy; back copies more than three months old, 50 cents per copy. Formerly published (prior to September, 1946) as the Technical Section of National Petroleum News, devoted to REFINERY MANAGEMENT and PETROLEUM CHEMICAL TECHNOLOGY and including International Petroleum Technology. Trade mark registered U. S. Patent Office. Copyright 1947 by The National Petroleum Publishing Co.

Let's talk shop

The petroleum industry is a vital part of America . . . employs a million and a quarter of us . . . comprises over 34,000 companies engaged in research, production, refining, transportation, marketing and distribution . . . contributes to some 5,400 products that make our way of life a better one.

Despite all this we need friends. Here's why.

The average American has a hazy conception of the petroleum industry and the part it plays in the nation's economic picture . . . thinks that natural resources are being squandered . . . that new developments are being withheld from him. These ideas are dangerous; dangerous to us, to our jobs and to our future. Now is the time to correct those thoughts, to take advantage of the fact that people who know the industry well think well of it.

Each of us can help by talking shop. What we say to our families and friends will help create a better understanding of the industry's contributions to the progress of the nation.

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What's Happening!

SEPTEMBER 1
1947

Summary of Current Developments Concerning Processing Men

HIGHLIGHTS *Eleven oil companies form American Independent Oil Co. to operate in foreign oil territories . . . . Average refinery runs of 5,160,000 b/d through next March required to meet product demand, is forecast . . . . Oil company to build plants to make chemicals from by-products of Fischer-Tropsch gasoline-from-gas plants . . . . President Truman refuses to sign National Science Foundation Bill as passed by Congress.*

Contracts and Construction $30,000,000 solvent lube oil refinery to be built at Lake Charles, La., jointly by Cities Service Co. and Continental Oil Co., both of whom operate light oil refineries there. Designed for 6000 b/d of high VI lubes and including facilities for making bright stocks, neutrals and wax. Plant will be operated by new Citcon Corp., of which Cities Service owns 65% and Continental 35%. Constructing contractors Lummus Co. and Max B. Miller Co. . . .

The Texas Co. has contracted with Foster Wheeler to build 42,000 b/d crude distillation unit at its new Eagle Point, N. J. refinery, with M. W. Kellogg Co. for Fluid catalytic cracking plant . . . The Texas Pipe Line Co. and Shell Pipe Line Corp. will build a new, 500-mile 20-inch common carrier crude line from Cushing, Okla., to Wood River, Ill., at estimated cost of $22,000,000. Capacity, 150,000 b/d. Completion set for early '49 . . .

Imperial Oil Ltd., will spend around $7,000,000 in dismantling, moving and establishing at Edmonton, Alberta, Canol Project No. 1 refinery, which it purchased from U. S. government for $1,000,000. While total cost will be about the same as for new plant, present plan will put plant in operation 18 months earlier than new plant . . .

Continental Oil Co. to build 7500 b/d refinery at Billings, Mont., with catalytic cracking, desulfurization, polymerization and solvent asphalt extraction. Cost, $8,500,000. Construction contract to Jones & Laughlin Supply Co. . . . Kanotex Refining Co. to modernize its 10,000 b/d refinery at Arkansas City, Kans., installing Perco catalytic desulfurization and reforming, and enlarging vapor recovery and catalytic polymerization facilities. Koch Engineering is construction contractor. . . .

Construction started on cooperative $3,000,000 combination absorption-compression plant to be operated by Sun Oil Co. near Delhi, La., to charge 17,000,000 cu. ft. of gas daily, producing natural gasoline, propane and butane. Contract to Petroleum Engineering, Inc., Houston. . . . Magnolia Petroleum Co. has put into operation new $3,000,000 gasoline plant near Vanderbilt, Texas, charging 25,000,000 cu. ft. of gas daily and making natural gasoline, propane and butane. Hudson Engineering designed and built the plant. . . . Gulf Refining Co. to build 300,000-bbl. products terminal at Muskegon, Mich.

Crude Oil and Product Demand Average refinery runs of about 5,160,000 b/d will be required through next March to meet demand, and higher if stocks are to be built up to safe levels, the Economics Advisory Committee of the Interstate Oil Compact Commission states in latest report. This is about 3.7% higher than the average 4,975,000 b/d refineries ran to stills the first 9 months of this year. Forecast for crude runs to stills for the fourth quarter of '47 is 6,165,000 b/d and 5,130,000 b/d for the first quarter of '48. Present refining capacity, including some shut down, is given as 5,648,000 b/d.

To meet the pressing demand for kerosine and distillate fuels this winter, refiners must achieve larger yields of distillate fuel oils from crude and also build up stocks of these products in the immediate months ahead. The Committee's forecast calls for a conversion rate of kerosine and distillate fuels of 32.3% of crude run to stills in the first quarter of '48, at the expense of gasoline yield. This compares with a percentage volume yield of 23.3% estimated for all '47 and of 21.2% actual for 1946.

Report again emphasizes that refiners' difficulties arise from lack of facilities to move available oil into refining areas that need it, particularly the Midwest. Little relief is seen until some of the pipeline construction now projected is completed in 1948.

Petrochemical Stanolind Oil & Gas Co. will build plants to recover and refine chemicals produced as by-products at the two Fischer-Tropsch natural gas conversion plants of Carthage Hydrocol Inc., near Brownsville, Texas, and of Stanolind in the Hugoton gas field in western Kansas. U. S. Industrial Chemicals Inc. also is said to plan chemical plants for same locations. . . . Shell Chemical Corp. to increase capacity of its synthetic ammonia plant at Pittsburg, Cal. . . .

Anglo-Iranian Oil Co. Ltd. and Distillers Co. Ltd., London, will organize new British company to manufacture chemicals from petroleum bases. . . . Polymer Corp., Sarnia, Can., is quadrupling its ethylene production capacity to 120,000 lbs./day to meet increased demand for chemical manufacture. M. W. Kellogg Co. has construction contract. . . .

Production of benzonitrile on semi-commercial scale announced by Socony-Vacuum Oil Co., Inc. It is widely used in research work because of high reactivity with a large number of chemicals. . . .

United States Rubber Co. is to operate the 45,000-ton synthetic rubber plant at Borger, Texas, built and op-

erated for government by B. F. Goodrich Co. It adjoins butadiene plant operated by Phillips Petroleum Co. . . . Operation of government's Los Angeles synthetic rubber plant to be discontinued, also the plant of Southern California Gas Co., which produced butadiene by high temperature thermal cracking of naphtha. . . .

First commercial shipment made (8000 gals.) of ethyl alcohol from wood waste hydrolysis plant of Williamette Valley Wood Chemical Co., Springfield, Ore. Full production will be 10-12,000 gals./d.

Washington Armed forces will need more than 100,000,000 bbls. of petroleum products for year ending June 30, '48, refiners' conference with government representatives Aug. 18 is told. Requisition to be avoided unless refiners cannot voluntarily meet military needs. . . . President refused to sign National Science Foundation bill passed by Congress on grounds that putting control in hands of 24-member board of leading scientists denied his appointive powers. Congress can write new bill meeting Truman's objections or attempt to enact present measure over certain veto. . . .

Failure of Congress to give Bureau of Mines $30,000,000 more to spend on its Synthetic Liquid Fuels project and extend it for three years will not impede present program, which started in 1944. Estimated needs for 1947-'48 and money spent previously amounts to $22,500,000 of original $30,000,000 voted by Congress. Measure for new appropriation is on calendar for early consideration when Congress resumes.

War Plant Sales Sunray Oil Co., Tulsa, was high bidder ($5,100,000) for government-owned avgas plant at Duncan, Okla., and proposes to spend $2,932,000 for modernization and additional facilities. Original cost was $14,865,000. . . . Government-owned avgas plant near Catlettsburg, Ky., operated during war by Ashland Oil & Refining, offered for sale by WAA, bids to be opened Sept. 12. Cost, $16,500,000. . . .

Modern catalyst manufacturing plant at Paulsboro, N. J., operated by Houdry Process Corp. under government lease has been purchased by it from WAA. . . . Highest bid for surplus avgas plant near Texas City, Texas, operated during war by Southport Petroleum, was $3,250,000 by Petrol Terminal Corp., Philadelphia. Plant built in 1942 at cost of $11,498,000. . . . WAA approved sale of surplus avgas plant at Houston to Eastern States Petroleum Co., Inc., wartime operator, for $2,000,000. Original cost, $10,351,000.

Technical A standard Research Method for testing motor fuel knock and new standard aviation gasoline specifications, proposed by ASTM Committee D-2, are being submitted to letter ballot of committee members. If approved they must also be accepted by ASTM executive committee, before becoming tentative standards. Objections to including Research Method as ASTM standard are coming from Mid-Continent refiners and natural gasoline manufacturers. . . . Lubricants and Liquid Fuels Technical Committee of Federal Specifications Board is planning to invite refiners' representatives to Washington in October to discuss Motor Fuel M specifications.

In Foreign Oil Fields A group of 11 independent oil companies have formed the American Independent Oil Co. to operate in foreign oil fields, particularly the Middle East. It is incorporated in Delaware with authorized capital of 1,000,000 shares of no par value. Assets of the group are in excess of a billion dollars. President is Ralph K. Davies, wartime deputy administrator of WPA.

Participating concerns are: J. S. Abercrombie, Houston; Allied Oil Co., Cleveland; Ashland Oil & Refining Co., Ashland, Ky.; R. K. Davies, San Francisco; Globe Oil & Refining Co., Wichita, Kans.; Hancock Oil Co. of Calif., Long Beach; Honolulu Oil Corp., San Francisco; Los Nietos Co., Los Angeles; Phillips Petroleum Co., Bartlesville, Okla.; Signal Oil Co., Los Angeles; Sunray Oil Co., Tulsa.

A formal statement by President Davies recognized that the launching of a long-term foreign oil program is a precedent for independent operators. It continued:

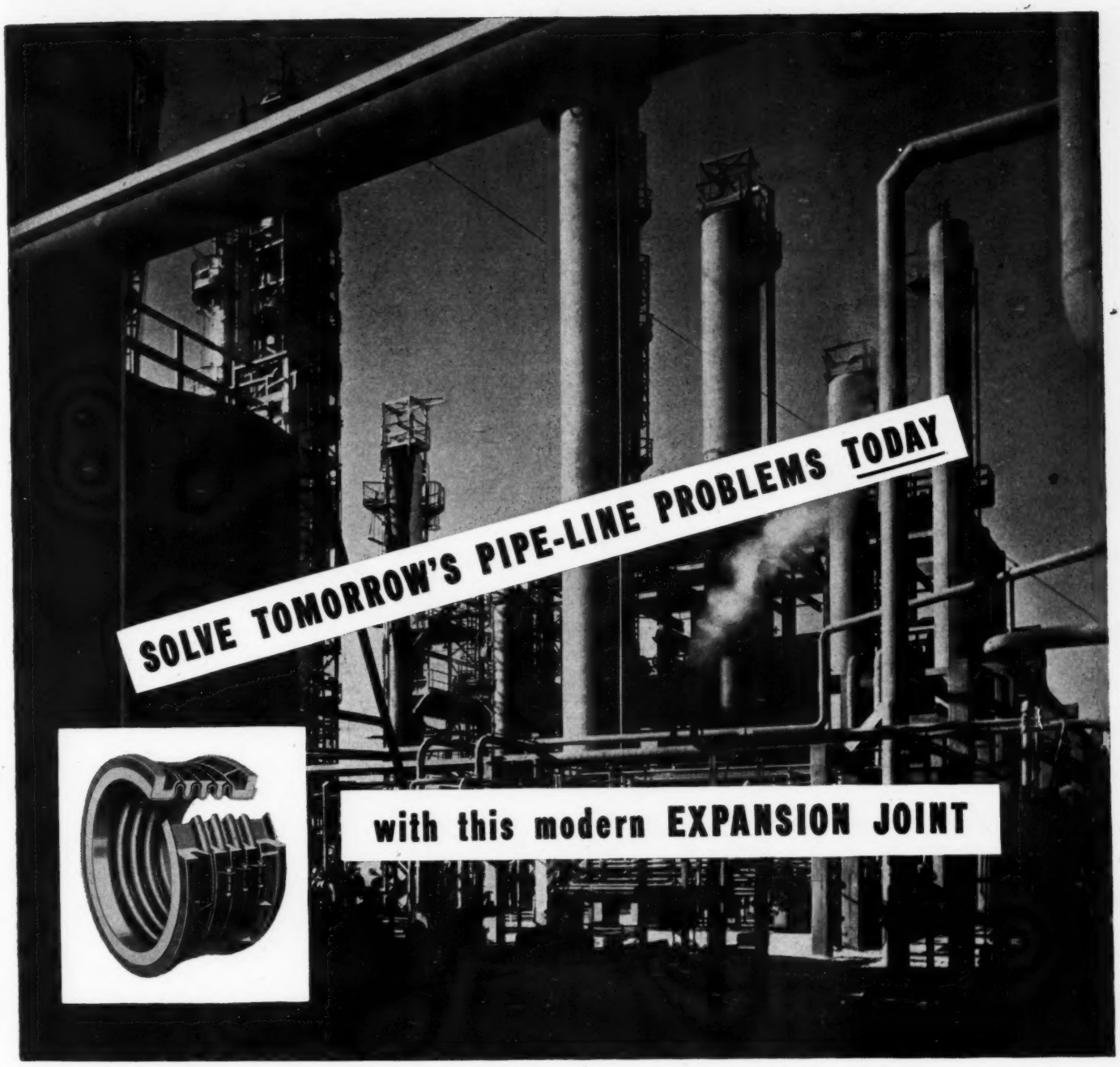
"Nevertheless, we believe that the interest of the American oil consumer will be best served by the active, substantial and permanent participation of American independent oil operators in the international field. Certainly all will agree that the consumer is in a more favorable position when there is competition by the many, rather than control by the few, however well-intentioned and beneficent. . . .

"Before many years, more oil will probably be produced abroad than in U. S., even if our present high rates of more than 5,000,000 b/d should be substantially increased. To deny the benefits of this foreign production to American consumers, to supplement our domestic supply might subject them to the payment of unduly high prices for products. To deny foreign crude to the domestic refineries might force abroad an increasing amount of the refining of foreign crude and thereby materially lessen our exports."

Top Names in the News D. J. Smith, executive vice president, Pan American Petroleum & Transport Co., made president, succeeding E. G. McKeever, who died July 9. . . . Edward L. Shea, president of North American Co. since 1939 and previously president of Tide Water Associated Oil Co., elected president Ethyl Corp., succeeding Earle W. Webb, who becomes board chairman. . . . E. V. Murphree, executive vice president, Standard Oil Development Co., is president, succeeding Robert P. Russell, resigned. . . .

William C. Kinsolving, formerly manager pipe line operations, Sun Oil Co., is president of Sun Pipe Line Co. (Texas) succeeding John G. Pew, who retires. . . . L. H. Prichard, president of Anderson-Prichard Oil Corp. since its organization in 1922, becomes its first board chairman. Roland V. Rodman, formerly president Bay Petroleum Corp., Denver, new president of Anderson-Prichard. . . .

Gordon R. Kay, vice president of Bay Petroleum Corp. and Chalmette Petroleum Corp., elected president succeeding R. V. Rodman. . . . C. Kenneth Baxter, director of Deep Rock Oil Corp. since 1941, elected chairman of board and president, succeeding as president Henry N. Greis, who died in Tulsa July 16.



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PETROLEUM PROCESSING
SEPTEMBER, 1947

Petroleum Steps into Breach As Supply Source for Critical Chemicals *

By J. OOSTERMEYER
President, Shell Chemical Corp.

The outlook for some important organic chemicals, demand for which has outrun the former established means of supply, is appraised, together with the role which the petroleum refiners may assume in supplying them. Concrete examples are given of how synthetics from petroleum bases are helping to solve shortages in the fields of alcohol, solvents and resins, glycerine and benzol. Specific economic factors in some cases are discussed.

THE basic or ground-swell movements in the chemical supply picture these days have superimposed upon them a lot of confusing ripples due to the generally upset condition of the post-war period. Let us try to get these factors into their proper perspective by dividing chemical shortages into three types:

First, short-term shortages due to depleted inventories, pent-up consumer demand and momentarily high purchasing power. Every industry has the problem of contending with these shortages at the very time that it is struggling to reconvert from wartime to peace-time production, but I believe we all have them pretty well appraised by now and see our way out of the woods.

Second, longer-term shortages due to demand exceeding production capacity, but not raw material supply. During the war, and in many instances because of the war, we developed new demands for many staple chemicals and found ourselves at the end of hostilities with inadequate facilities to meet them. This situation is being remedied as fast as we can throw up the additional plants or convert installations built by the Government during he war. Among the many examples of shortages which will soon be alleviated in this manner are those in ammonia, methanol, formaldehyde, chlorine, caustic soda, soda ash, sulfuric and other acids and so on.

Third, is the really basic shortage which arises when the demand for a given chemical outgrows not only the productive capacity but *also* the supply of the raw material from which it is made. This is the type of shortage which everyone expects the chemical industry to solve by turning to sawdust and the cornstalks.

This third type of shortage is with us in a number of instances right now, but the raw material which is coming to our rescue in case after case is not sawdust or cornstalks—but petroleum.

Synthetic Ethyl Alcohol

1. As a first example of this rescue by petroleum let me select ethyl alcohol. Many large industrial users of ethyl alcohol would have to go out of business if they were forced to depend on the fermentation of expensive grains. Their principal source of supply has always been the relatively cheap blackstrap molasses, and over the years the price of blackstrap has been a matter of the greatest interest and concern. Today, with demand outstripping the normal molasses supply, and the latter endangered by new ion-exchange methods of sugar refining which yield more sugar and less molasses, industrial alcohol has been as high as $1 per gallon. The future would indeed look discouraging were it not for the presence on the scene of two new raw materials, wood wastes and petroleum gases.

Two commercial plants for the manufacture of ethyl alcohol from wood wastes are now in operation in the Pacific northwest, following successful pioneering work in Canada and Germany. Synthetic ethyl alcohol from petroleum is not new, having been successfully manufactured in West Virginia and the Gulf Coast area for many years, but production will soon be greatly increased by at least one large new plant in Texas. It is my confident prediction that we shall see the present price drop and stabilize within the next year or two in the 30-40c per gal. range, at which firm level we shall all profit by the further development and growth of the many industries to which this is a vital intermediate or solvent.

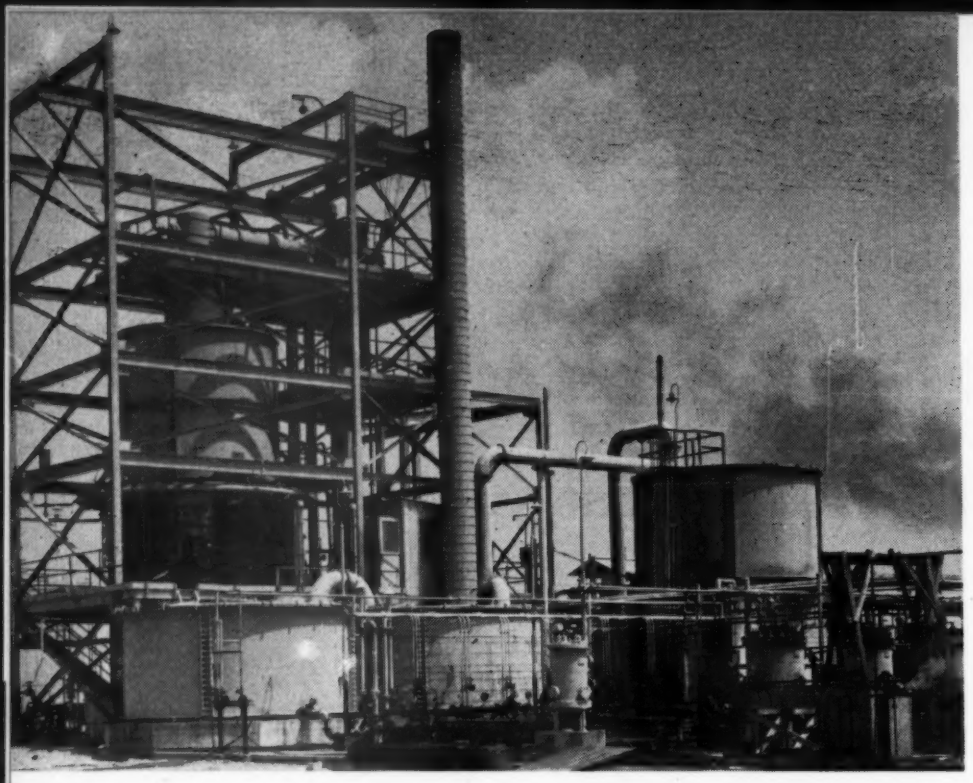
Other Alcohols, Solvents

2. The tight ethyl alcohol situation is also being relieved to an increasing degree by replacement by other alcohols derived largely from petroleum and natural gas. Methyl alcohol, which first came from wood, then from coke-oven gas, is being made from natural gas in all the new plants. Synthetic methyl alcohol, which will soon be available in plentiful supply at a reasonable price, is expected to displace ethyl permanently from such uses as anti-freeze.

Isopropyl alcohol is produced entirely from oil refinery gases and, at its stable price in the 30-40c per gal. range, has been displacing ethyl alcohol from many uses such as lacquer solvents and rubbing alcohol. Very recently, normal propyl alcohol, also a petroleum product, has appeared on the market at an attractive price. This new alcohol will also undoubtedly capture markets which ethyl alcohol will have to regain by coming down in price.

This discussion naturally enough opens up the whole question of solvents. Solvents, in their quiet, unobtrusive way, have been the work horses of the chemical industry, without which many of the striking advances in the fields of lacquers, finishes, plastics and synthetic fibers would never have been possible. We have come a long way from the day when a purchasing agent bought solvents from a short list containing such familiar names as wood spirits, petroleum

* Abridged version of a paper under the title, "Critical Chemicals and New Chemical Developments", presented before the 32nd Annual Convention, National Association of Purchasing Agents, New York, June 3, 1947.



Acid absorber unit at Shell Chemical Corp.'s Houston plant. Here hydrogen chloride is removed from the products of butadiene cracking furnaces and converted to marketable hydrochloric acid, by absorbing it in water. The butadiene goes on for further purification

ether, ligroin, naphtha and benzine spelled with an "i."

Nowadays any one of a dozen suppliers will submit a thick catalogue filled with tables of data about miscibility, compatibility and kauri butanol values. They will send their bright young men into your plant to prescribe a solvent or mixture of solvents to dissolve anything you have, carry it in solution just the way you want it, and lay it down whenever and at whatever rate you specify. The list gets longer every day, and an increasing number of the new entries is coming from petroleum. Avid, though the demands may be, supply is catching up fast and bringing with it that boon to the purchasing agent, a reasonable and stable price structure.

Phthalic Anhydride

3. From solvents it is an easy step into finishes, paints, varnishes, lacquers, enamels and coatings of all types. At the present pace of development in this important field, there were bound to be shortages—serious shortages—but these too are being met. Among the worst recently has been the shortage of linseed oil and of drying oils in general. Many measures are contributing to its alleviation. The planting of flax is being encouraged by the government, and imports are being increased from such countries as Argentina. Soy bean oil is coming into the picture to a steadily increasing extent, and great things are being done with fish oils. A notable advance has been the application recently of solvent extraction techniques, old by now in oil refining, to the separation of natural oils into drying and edible fractions.

Most important, nowadays, among the finishes are the synthetic products such as the alkyd resins. Here is where we have run into a real ring-tailed shortage of the basic type—a case where we have had to find an altogether new raw material. One of the primary constituents of alkyd resins is a synthetic chemical which goes by the imposing name of phthalic anhydride. The raw material from which it has traditionally been made has been naphthalene, a coal-tar product.

When you make steel, you need coke. When you make coke you get coal-tar, and coal-tar contains just so much naphthalene. As long as the steel mills keep going, and the naphthalene supply exceeds the demand for phthalic anhydride you are sitting pretty and the development and application of alkyd resins goes merrily on. There is, however, no relationship between the consumption of alkyd resins and that of steel, and for some time now we have been watching a really striking rise in the former without any material increase in the latter. Today it is pretty well recognized that, although everything is being done to increase the recovery of naphthalene from coal-tar, the amount we need simply is not there. We must go to some other raw material for our phthalic anhydride.

Fortunately research in the petroleum chemical field has come up with the answer, perfecting within the past few years, the manufacture of phthalic anhydride from ortho-xylene, a component of gasoline. The first petroleum phthalic plant is now in successful operation on the West Coast, and oil refiners all over the country are busy extracting ortho-xylene from their gasoline while the phthalic producers are converting over from 100% naphthalene operation as fast as they can. From the very outset ortho-xylene has been made available at a price only slightly above the coal-tar by-product value for naphthalene, so that the chemical industry can report with some pride that the day has been saved for alkyd resins as far as phthalic anhydride is concerned.

Synthetic Detergents, Glycerine

4. Now, in saying that the future of alkyd resins is assured as far as phthalic anhydride was concerned, the expression is used advisedly. These resins have simultaneously run into another serious basic shortage; that of glycerine, which is another major component. Here again, as in the case of naphthalene our national supply of an important chemical has been traditionally tied to another unrelated operation, the manufacture of soap from fats and oils. When fats are split or saponified the main product is soap, while glycerine is simultaneously obtained in a dilute impure solution from which it is recovered and purified whenever the operation is justified by the market demand and price.

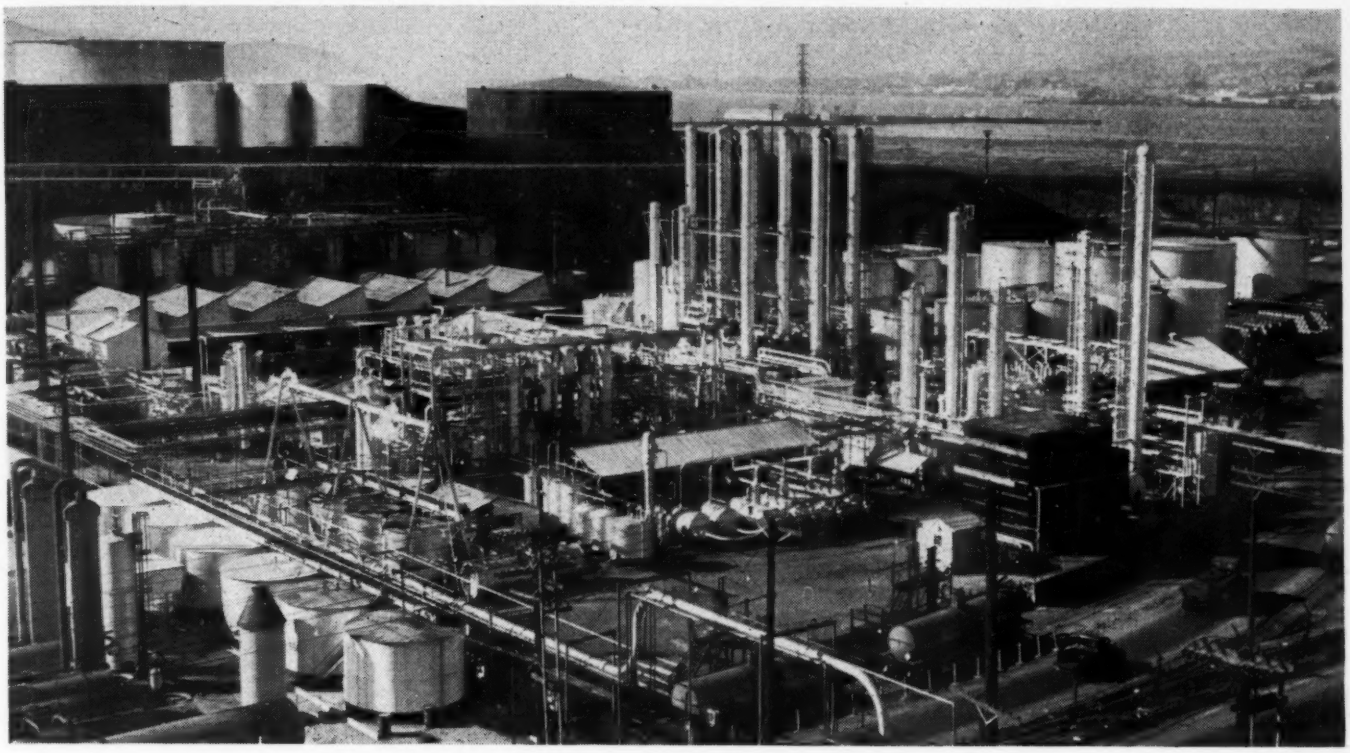
Few chemical products have experienced the fluctuations in supply, and consequently in price, that have characterized the history of glycerine. In 1933, for instance, it was listed at about 10c per pound and there were many idle recovery units around the country. In sharp contrast we have the situation today in which glycerine has been quoted for some time at prices above 50c per pound.

Glycerine has been short before, and has sold at high prices, but we have always pulled out of it. Will we do it again? I for one am inclined to doubt it, and, as I will point out in a moment, we are gambling fairly heavily on that judgment.

On the supply side, we have of course a very tight world-wide situation with respect to fats and oils, which we will have for quite some time. Any chemical manufacturing process which is forced to compete for raw materials which are edible, or which can be made edible, is in for some tough going.

A shortage of fats and oils has naturally meant a shortage of soap. Synthetic detergents, the so-called "soapless soaps", many of them based on petroleum, have stepped into the breach and are doing a fine job. These products are now competing with soap on an equal price basis, while at the same time offering improved properties such as sudsing in hard water and absence of scum. I do not believe they will ever yield their gains to soap again, no matter what happens to the supply of fats and oils. Whenever less soap is made, there is less by-product glycerine to recover.

Now, let us look at the demand side of the picture. During the war, the re-



General view of the Shell Chemical plant at Martinez, Calif.

quirements for nitroglycerine, the main ingredients of dynamite and of propellants for shells and rockets, increased greatly. You will recall the fats drive to help out in building up the national glycerine supply. This particular demand has, of course, been intermittent in the past and we naturally hope it will continue to be more and more so in the future, but the disagreeable fact that it may recur on short notice cannot be overlooked.

At the same time, however, we have been steadily building up non-military demands for glycerine, which have not shrunk with the return to peacetime conditions but are certain to maintain and increase their growth. In addition to its use in alkyd resins already referred to, glycerine is needed in compounding cosmetics, softening cellophane, moistening tobacco and several other equally promising lines.

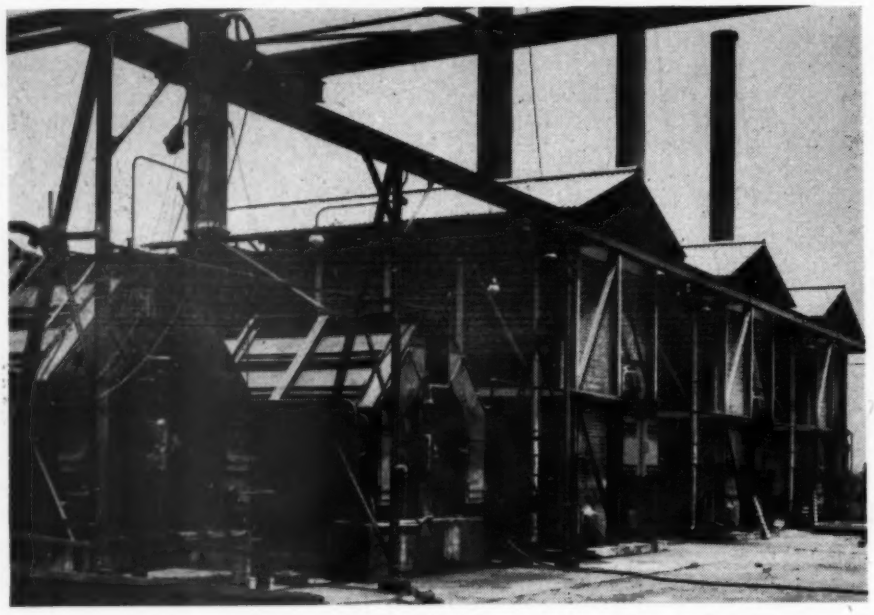
So we have a condition of increasing demand and decreasing supply. What are we doing about it? Well, we are doing something we should have had the foresight to do some years ago. We are finally building a plant in which we will make glycerine synthetically out of petroleum and salt, both abundant raw materials. This step will free a chemical of vital national importance in times of war and peace alike from dependence on the uncertain supply of a perishable raw material.

This $7,000,000 plant, which is going up on the plains of Texas as fast as present-day conditions will permit, will not be ready until the spring of 1948. I don't believe that we in the chemical industry can excuse ourselves for not being ready for the glycerine shortage half as plausibly as we can for the other shortages spoken of before. The synthetic process was ready 10 years ago. We should have been able then, or certainly in the years following, to anticipate the wartime requirements and to extrapolate the trends in industrial utilization so as to predict the present short supply.

It is easy, of course, to place all the responsibility on the supplier with the synthetic process. All he had to do was figure the future, put up his $7,000,000, wait a year or two while his plant was being built. Then he could set out with his order book on a tour of flinty-eyed, hard-hearted purchasing agents, each with the old-fashioned notion that glycerine was something you could get for nothing if you bargained long and hard enough. We chemical suppliers are a hardy and adventurous breed, but there are some cases even in the chemical business when discretion is the better part of valor. We realized it would be in the long-term interest of the whole industry to have synthetic glycerine, but we also realized that, interesting and important though it might be, we were up against a case where the capital risk was just too great compared to the return which could be computed on the basis of past price performance even with a good "crystal ball" factor thrown in.

This is substantially what has held up synthetic glycerine. I do not believe

Row of centrifugal pumps used in handling synthetic organic chemicals at the Houston plant of Shell Chemical Corp.



Cracking furnaces at Shell's Houston plant. The two at the left produce butadiene for synthetic rubber, and the three at the right yield acetone. All five furnaces are fired with natural gas

I am violating any confidences when I tell you it might not be on the way even now, if we had not come across something new in what I might call industrial statesmanship. Some of the biggest buyers of glycerine—men who would be in the strongest position to ride the by-product price down when the time came—elected instead to take the enlightened long-range view and shoulder some of the supplier's unwarranted burden of risk by signing long-term contracts at a fair price. Had we had the vision and foresight to get together and do this sort of thing years ago there need not have been any waste fats drive and there would have been fewer gray hairs among the purchasing agents who are now scrambling for the short supplies of glycerine at high prices.

Petroleum Aromatics

5. As a fifth and final example of chemical shortages, what looks as if it will be one of the most serious, is that of benzene.

Benzene or benzol occurs, together with other aromatic hydrocarbons such as toluene and xylenes, in coal-tar which for many years has been virtually their only source. Just like naphthalene, benzene, toluene and xylenes are by-products of coking and have been sold in the past at whatever prices the market would support. Toluene and the xylenes have found uses as solvents and for many years coal-tar distillers were able to get prices in the neighborhood of 30c per gal. for them. Benzene, however, occurs in coal-tar in several times the volume of toluene and xylene and the supply was always so greatly in excess of demand that its price leveled off about 15c per gal. and most of it had to be worked off in motor gasoline.

Cover Picture

Photograph on the cover is a view of part of the Houston plant of Shell Chemical Corp., showing, left to right: Distillation columns for purification of isopropyl alcohol and acetone; acid concentrating unit; and a part of the reaction unit of the isopropyl alcohol plant. Isopropyl alcohol and acetone are manufactured from propylene produced in refinery cracking operations.

It was not until World War II that petroleum moved in to challenge the undisputed position of coal-tar as a source of aromatics. Toluene is the big "T" in TNT and, although coal-tar toluene got us through World War I with a little squeezing, it was obvious before the recent unpleasantness that this would be totally inadequate. Fortunately, we had learned how to make toluene from petroleum about 1939, so that new plants began to sprout up in oil refineries all around the country and by April, 1942, a single petroleum plant was producing more toluene than the entire coal-tar industry. Today a lot of these plants have closed down, but there is still enough petroleum toluene on the market to keep the price down around 23c per gal., a firm level at which the oil people can keep some of their plants going at a reasonable profit. Also, since benzene, toluene and the xylenes are closely related chemically, the petroleum plants can be modified without too much trouble to produce any one of the three.

Since the petroleum people in manufacturing these aromatic hydrocarbons start with a raw material which has motor gasoline value, 15c benzene was comparatively safe from their competition. With petroleum benzene in the 23-plus price range, the oil people naturally looked elsewhere for benzene supplies and the coal-tar people kept meeting increasing industrial demands by pulling more and more benzene out of the big reserve pool, which they were actually selling to oil refiners to put into motor gasoline in order to get rid of it.

However, the industrial demands for benzene have kept on increasing. We ran out of natural phenol some years ago, and have been making our new production synthetically from benzene. Phenol has been going into many products with expanding markets, but outstanding among them are the phenol-formaldehyde resins, from which we make telephones, electrical fixtures, plywood adhesives and many other things in everyday use. From benzene we also make aniline and all the aniline dyes. In the last few years, we have built up an enormous capacity for another important benzene derivative, styrene, which goes into synthetic rubber and into polystyrene plastics. Then there are the synthetic detergents based on benzene and the popular new insecticides DDT and 666. One more example of an important new product with large demands for benzene is nylon.

We are fast reaching the point at which the coal-tar distillers will have no more benzene to work off in motor gasoline, and it will not be long before the oil refiners will be selling this product instead of buying it. This is already foreshadowed by a steadily rising price, recent benzene quotations being 19c per gal. I have a very strong feeling that this is no short-term inflationary price rise, but simply a case of a chemical which has been in oversupply for many years finding its demand catching up and bringing it up to the general price level of comparable products.

I should like to be able to wind up my series of examples by stating that, in stepping in to solve one of our most serious shortages, petroleum was going to reduce the market price of benzene as it did those of toluene and xylenes. Unfortunately, that is not in the cards and we might just as well readjust our time-worn ideas about buying benzene the chemical at the price of benzene the fuel. I will say, however, that there will be a point—which is not too far off—at which petroleum benzene will stabilize its price, probably just slightly above that of the other two related materials.

I have tried to convey to you a general impression of how fast things move in our particular business and of how well equipped we must be with laboratory research and how well in advance of our immediate requirements with economic research, to define and interpret conflicting trends, and with market research to predict what products are going to be wanted by the time we can get the plants built, and to know whether enough will be paid for them to enable us to recover our capital and earn a few dollars for our stockholders.

TOMORROW

... IN PETROLEUM TECHNOLOGY

Current technological and economic developments discussed here in the light of their future bearing on petroleum refining operations include:

- **New uses developing for acrylonitrile.**
- **Petrochemicals—threat or promise?**
- **Potential benzene shortage provides opportunity to petroleum refiners.**
- **Petroleum detergents facing quantity market.**
- **Stanolind will market Hydrocol chemicals.**

New Markets Studied For Acrylonitrile

AS mentioned in *NPN Technical Section*,(1) acrylonitrile is currently being produced in quantities in excess of 10,000,000 pounds per year. Chief use since its commercial introduction in 1939 has been the production of the Buna-N types of synthetic rubber, but other uses are known to be under development.

One of these may be "du Pont's long-secret new fiber. Known within the company as 'Fiber A,' this *acrylonitrile polymer* is now being tested in several textile mills."(2) No further information is at hand, however, although the textile industry has known since the war that du Pont was readying one or more new synthetic fibers for the market.

Typical, perhaps of the less glamorous research on uses of acrylonitrile are some experiments recently reported on "Action of Acrylonitrile on Viscose Carboxylated Rayons."(3) The carboxy ether yarns obtained, while suitable for the manufacture of specialized fabrics, are alkaline and water soluble. Volume markets would not be expected for such yarns, but they will perhaps constitute another use for acrylonitrile which will add to the growing total.

Thornton(1) stated there was a potential market for acrylonitrile of 250,000,000 pounds. With Phillips, Shell, Sinclair, and other petroleum comanies interested in this chemical, along with such chemical companies as American Cyanamid and Dow, it is virtually certain that du Pont's new fiber will be but one of a number of a new, large-scale uses.

Petroleum Chemicals— Threat or Promise?

TO THE chemical industry, this subject continues of considerable importance, as witnessed by the editorial attention(4) given to two recent papers presented at the 75th annual meeting of the Manufacturing Chemists Assn.

Information such as contained in these papers—"Petroleum as a Source of Chemical Raw Materials", by H. W. Fisher, president of Enjay, Inc., and "Aromatic Chemicals from Petroleum", by George L. Parkhurst, president of Oronite Chemical Co. (chemical subsidiaries, respectively, of New Jersey Standard and California Standard)—has been the topic of many items in this feature. No one now decries the importance of petroleum as a chemical raw material. What the chemical industry is asking, however, is whether or not petroleum refiners are going to become chemical manufacturers on a large scale, thereby disrupting markets. As *Chemical Engineering* puts it, "What's to keep the oil refiners from moving in and usurping the major share of at least the raw-material business in the synthetic organic chemicals?

In answer to this, its editorial staff provides the following thesis:(4)

"The petroleum industry itself knows the answers. It is primarily and preeminently a producer and marketer of energy in the form of liquid fuels. It realizes that the whole range of commercial chemicals and synthetic products that might be made from petroleum would utilize only a fraction of 1% of the world's crude oil production. (?) By and large, it is not set up to deal in highly refined specialties. It makes its money on large-volume, low-margin products. It sees no percentage in selling expensively purified hydrocarbons at the price of gasoline or their gaseous fuel values. Its technology changes so rapidly that it is reluctant to enter into the long-term contracts demanded by chemical customers. It has no desire to build up the substantial inventories of chemical raw materials that must be held for relatively long periods and therefore become extraordinarily expensive from the view point of the petroleum refiner.

"Finally, and not exactly an unmixed blessing, is the very substantial chemical engineering problems yet to be solved in making some of these materials available to chemical manufacturers in usable form. This applies particularly to the relatively large quantities of oxygenated compounds concurrently produced in the Fischer-Tropsch (Synthine) process of making liquid fuels from natural gas."

With many of these points there is room for solid argument, certain to be resolved as time progresses. It may very well be, as H. W. Fisher is quoted as saying, that "by continuing the sympathetic and cooperative spirit which has marked past relations between these two industries (chemical and petroleum), the future development can redound to the benefit of both," and that the chemical relationship between the industries will be one of raw material supplier and consumer. However, it is not to be taken for granted that petroleum refiners are all going to be content with making low-profit products in quantity and selling them to others to make the quality products which command the higher prices.

Not that many petroleum refiners are likely, even eventually, to make plastic products, perfumes, or other consumer goods; but it is not improbable that more and more petroleum refiners will go further and further down the many-leveled stairs which stretch between raw material and final product.

Potential Benzene Shortage Is Refiners' Opportunity

AS MENTIONED in July,(5) the potential shortage of "coal-tar" aromatic hydrocarbons is opening a possibly lucrative field to the producers of chemicals from petroleum. Under these circumstances, it is particularly interesting to note a recent detailed analysis of "Benzene—Supply and Demand", since this article (6) takes cognizance of petroleum as a potential raw material.

In this article, Sullivan clearly presents

(1) Thornton, D. P., Jr., *NPN Technical Section*, 38, No. 10, R-221 (1946), "Processes for Making Nitrile Compounds Patented by Three Oil Companies".

(2) Anon., *Chemical Industries* 61, No. 1, 27 (1947), "For Your Information."

(3) Hollihan, J. P. and Moss, S. A., Jr., *Industrial and Engineering Chemistry* 39, No. 7,929 (1947).

(4) Anon., *Chemical Engineering* 54, No. 7, 95 (1947), "Petrochemicals—Threat or Promise?"

(5) Anon., PETROLEUM PROCESSING 2, No. 6, 491 (1947), "Tomorrow in Petroleum Technology—Aromatics from Petroleum Increase in Importance."

(6) Sullivan, F. W., Jr., *Chemical and Engineering News* 25, No. 28, 2000 (1947).

the "facts of life" of coal-tar benzene production: (1) average yield of coke from coal, 70-71%; (2) coke consumed per ton of pig iron, 1,800-1,840 pounds; (3) yield of light oil per ton of coal, about 2.85 gallons; (4) benzene yield from light oil (high attained in 1944), 57%. Anticipating a high level of industrial activity for 1947 and 1948, he feels that benzene production for these years will be adequate to meet the rising demands for the production of styrene, phenol, aniline, chlorobenzene, solvents, nylon, detergents, maleic anhydride, and other products.

Moreover, he states that "while greatly increasing production of nylon is forecast, it seems probable that the raw material for this will be cyclohexane isolated from petroleum rather than, as in the past, the product of the hydrogenation of coal-tar benzene." As noted, du Pont will also produce nylon intermediates from furfural, all this benzene-substitute activity indicating "the seriousness with which one large consumer regards the necessity of 'diversifying the sources of nylon ingredients.' "

Referring to a reported expansion in maleic anhydride production which would require 8,000,000-10,000,000 gallons of benzene per year, Sullivan states that, "it would seem advisable that this versatile, valuable, and potentially cheap chemical be derived from butane. This is available in unlimited quantities at less than one-third of the cost of benzene, and the theoretical yield is considerably higher."

Looking into the future, Sullivan notes that demand for benzene products will probably not decrease proportionately with any recession in industrial activity, so that benzene demand will not decrease proportionately with production which, as mentioned, is directly dependent upon the demand for steel. In addition, the use of oxygen in steel making "may effect a 50% reduction in coke consumption," thereby greatly decreasing coal-tar benzene production.

In his analysis of the petroleum industry as a source of benzene, however, Sullivan seems unduly pessimistic. It is true that the yield of toluene and higher aromatics is greater in "normal" hydroforming operations than is the yield of benzene and that the benzene content of most American crude is very low. It is also true that the potential use of the Synthine process will not provide benzene either from natural gas or coal, especially since processes based on the latter material are likely to involve continuous gasification instead of coking.

However, it is not so certain that some petroleum companies may not decide to hydroform the hexane cut to benzene, even though, for purposes of quality gasoline production, isomerization of this fraction may have "greater economy and simplicity" to many. As mentioned in July,[5] certain hydroforming plants are now charging a C_6 cut in order to enhance the yield of xylenes, currently selling for more than 23c/gal. Benzene has traditionally sold for much less than this—about 13 cents from 1937-1945—but the same issue of *Chemical and Engineering News* that carries Sullivan's article notes a market price of 19c/gal. on July 2. In view of the also certain potential shortage of benzene, even and perhaps especially in case of a business recession, it would seem likely that the price for benzene will approach a point where it will be profitable for petroleum refiners to manufacture it.

Quantity Market for Petroleum Detergents

MUCH has already been said concerning the potentialities of detergents from petroleum, a field in which petroleum chemicals are already in use to the extent of hundreds of millions of pounds annually. As time goes on, however, it appears that even "optimistic" predictions may have fallen short of the levels which will actually be attained.

As pointed out by *Chemical Industries*, [7] "current, production is somewhere near 250,000,000 pounds (per year), and plant facilities built, or under construction, should add another 125,000,000 capacity. Soap consumption hovers near the 3,250,000 000 level. Thus, as yet, synthetics have made no tremendous inroads as far as soap is concerned, but the makers of the newer products talk confidently of a billion pound per year volume within the next few years."

Marketwise, sythetic detergents are of potentially great interest because the soapmakers themselves are pushing them. Knowing that the profit lies not in selling soap but in selling " 'sizzle'—speedy dishwashing, freedom from tattletale gray, mountains of suds, and so forth," the soapmakers "are ear-deep in the synthetic business, fighting for a lead position, aware of the fact that the primary assets can be theirs—trademarks such as Vel, Dreft, Breeze, and Tide—assurance that they will control the 'soap' business."

Space here does not permit an analysis of the raw material situation, in which petroleum-based alkyl aryl sulfonates are playing an increasingly important part, along with (more expensive) detergents based on such petroleum chemicals as ethylene oxide. Fatty acids from natural oils and fats are dominant raw materials at present, but these, too, may be derived from petroleum. Certain important detergents, at present, are also based on coal.

"The only synthetics which appear to be competitive with soap (on a purely price basis) are the petroleum or coal-tar derivatives. At present, at least, the lion's share of the market is held by the sodium aklyl sulfates (Dreft), sulfated monoglyceride (Vel), and alkyl aryl sulfonates (Swerl). Leader in the polyethylene oxide group is General Aniline's Glim . . . Noteworthy is the fact that some of the aforementioned brands, which originally carried fat-derived synthetics, are now using (petroleum-derived) alkyl aryl sulfonates, in part or in toto."

Large soapmakers, it is said, will produce quantities of their own synthetic detergents by buying petroleum cuts, partially-processed raw materials, or the finished products, and will also strive to dominate packaging and distribution. "Smaller soapers" will probably "buy the finished product from the chemical industry" and "will blend, compound, and sell.

"Thus the super-merchandising abilities of the soapmakers and the volume-producing, cost-reducing capabilities of the chemical industry are being combined. They can easily add up to a billion pound market," in which petroleum companies and petroleum chemicals will play the dominant role.

Stanolind Will Market Hydrocol Chemicals

THE recent announcement [8] that Carthage Hydrocol "will market its chemical products (alcohols, aldehydes, ketones) through Stanolind," potential builders of the second announced Synthine plant, is probably a welcome indication to the chemical industry that the price of oxygenated chemicals will not be slashed indiscriminately in any near-future price war.

Construction of Carthage Hydrocol's Synthine plant was scheduled to begin last month, all preliminaries having been completed. Stanolind's Synthine plant, to be located in the Hugoton gas field in Western Texas, is to be erected next year, according to announced plans.

Apparently, however, Stanolind's desire to enter the Synthine by-product chemicals field as soon as possible, or some unannounced change in plans for its own Synthine plant, has caused it to plan what is rumored to be a $12,000 000-$15,000,000 chemical plant at Brownsville, Texas, on an 85-acre site adjacent to that of Carthage Hydrocol's plant.

The earliest report of this move [8] stated that "sales policy will favor contracts with a few large customers."

No inkling has been given as to exact chemicals to be produced, although the list will probably include ethyl alcohol, acetaldehyde, acetone, and numerous other oxygenated chemicals. As mentioned last year, Standard of Indiana, Stanolind's parent company, has evinced an interest in the OXO process for preparing long-chain alcohols from Synthine olefins.

Whatever the case, this plan is of considerable significance to both the petroleum and chemical industries, and further developments will be closely watched.

(7) Anon., *Chemical Industries* 61, No. 1, 33 (1947), "What's New—Superlative Synthetics."

(8) Anon., *Chemical Industries* 60, No. 6, 931 (1947), "For Your Information."

PLANT PRACTICES

Practical Tips and Ideas for Improving Refinery Operations

Floating Pumphouse in River Channel Supplies Refinery with Cooling Water

ONE of the big headaches in many refineries, particularly in the Southwest, is industrial water in large quantities for cooling purposes. The "Mighty Mississippi" rolls by not far from the Wood River refinery, and settles that problem for Standard Oil Co. (Indiana). Because of the floods which too often sweep that stream, the refinery proper was built more than a mile from the river but near an old slough, or channel, from which water was pumped. To assure adequate supplies in time of low water, the slough must be dredged at least once annually.

Several years ago it was realized the growing refinery would need more water. Also, the old intake facilities had suffered in time of very high water, during which some refinery property was inundated. It was then that the idea was conceived of building the floating pumphouse.

Foundation for the pumphouse consists of 8 carbon steel drums which became available when old tube stills were abandoned. They are 10 ft. in diameter by 30 ft. long, internally braced to resist crushing action from ice. To them were welded saddles of boiler plate, on which structural steel members were supported and from which the entire pumphouse is suspended.

That portion of the "vessel" below the upper railed deck (but above water line) is of steel; the superstructure is of wood. The structure is anchored against lateral movement by four steel cables attached to "dead men" buried at the top of the bank. Tension in each is controlled by a hand-operated winch.

It was decided to use the old 40-in. main which was laid when the refinery was built, and protect it against leakage by concreting it in. Connection to the pumphouse, however, is a 36-in. line. To compensate for changes in elevation two pairs of Moran ground joints were used. In the picture they are visible at the ends of the inclined ramp. Each pair will give 22.5° of angular movement in any direction, permitting the pumphouse to move, relative to the fixed main, as much as 45° in any direction. Actually, elevation of the pumphouse relative to the fixed main changes as much as 35 ft. as river stages dictate.

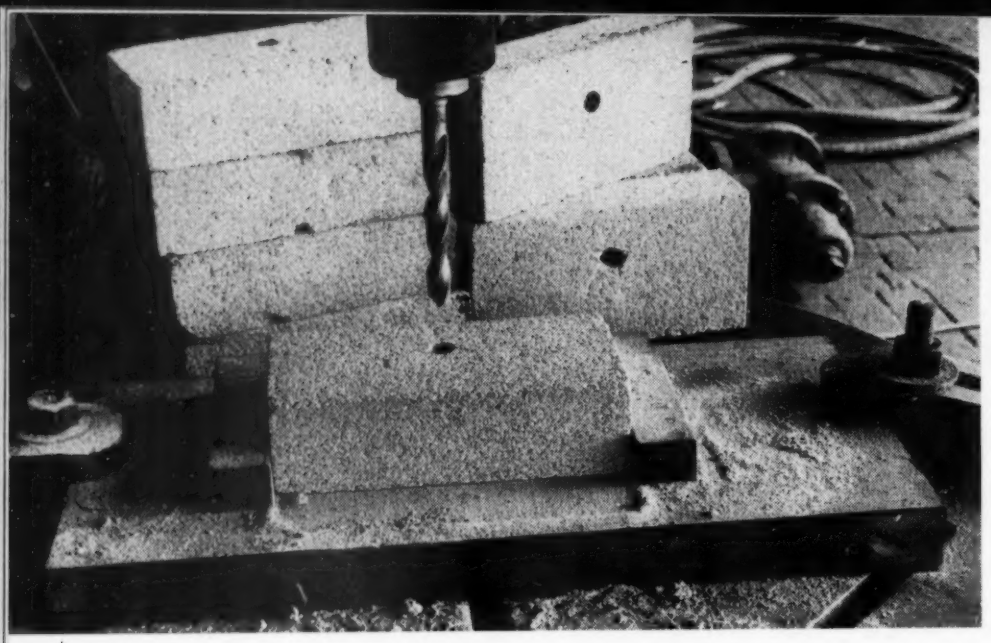
Three centrifugal pumps are installed in the pumphouse, driven by 2300 volt, synchronous motors. Two of the pumps are good for 12,000 gpm while the third is rated at 25,000 gpm. Ordinarily, only the 25,000 gpm pump is run, while the other two are available as standbys. Switchgear is located at the far end of the vessel in an enclosed, electrically-heated room, and the pumproom may be heated similarly. Ample room is available for maintenance and a traveling crane is provided. (Note monorail running along above the 36-in. pipe from shore to ship.).

Electric heat also is used to keep the two water intakes free of ice in winter. One or more immersion type heaters are used and normally one intake is sufficient. Sliding screens are used to prevent admission of solid debris; filters capable of removing suspended solids are not used.

The long channel, about 3/4 mile, acts as a settling basin and drops out much of the silt which otherwise would clog condenser boxes and other refinery equipment. Only mild currents are experienced and then only during abrupt changes in the river level.

Since the pumps are under automatic control, the pumphouse is visited only about once or twice per shift, except for occasions as required by maintenance schedules.

Indiana Standard's Wood River refinery cooling water comes from the Mississippi via this floating pumphouse. Vertical movement is as much as 35 ft. with changing river stages



One of three set-ups on which 1750 bricks were drilled in three hours at Standard Oil Co. (Ohio) Toledo refinery

Refinery Machine Shop Reduces Down-time In Repairs on Fire-Damaged Furnace Arch

UPON the failure during a recent fire of the firebrick arch of a furnace in the Toledo refinery of Standard Oil Co. (Ohio), the plant's machine shop was called to the rescue to provide the necessary replacement brick—an unusual demand upon a machine shop.

Sufficient regular firebrick wasn't on hand to make repairs—and the closest supply was west of the Mississippi River. The plant did have, however, a quantity of insulation brick (2½ x 4½ x 9 in.) which, if it could be drilled to fit the arch hangers, would do the job.

The bricklayer foreman took his problem—1750 bricks, each requiring a 5/8-in. hole—to the machine shop. The first reaction of the foreman there was that a regular steel drill would burn up after cutting through a half dozen bricks, and that a masonry drill would be required. After seeing the brick, however, he decided he could do the job by grinding the cutting edge of a standard twist drill flat, like the old-type boiler-maker's drill.

While a carpenter was making up some simple wooden jigs to hold the bricks in the proper position, a machinist ground the drills flat. Three drill presses, one of which is shown in the photograph, were set to work on the job, with two men on each press. In less than three hours the whole lot of 1750 bricks was finished, and the original drills held up for the entire job.

Water Pool Stops Welding Heat Distortion Of Heavy Cover Plate for Exchanger

By JIM WALLEN, Ashland Oil & Refining Co.

WELDING a spider of reinforcing structural members on a flat cover plate, about four ft. in diameter, for an exchanger head presented a difficult problem recently for the weld shop at Ashlan Oil & Refining Co.'s No. 1 refinery.

It was necessary to keep the welding heat at a minimum to prevent distortion of the machined face of the plate, otherwise a tight seal would have been impossible when the plate was replaced on the exchanger shell.

As worked out by Welding Foreman Eddie Artler and his crew, the solution was to use water. A shallow pool was constructed on the concrete floor of the weld shop with the use of a clay dam, as shown in the photograph. Several small blocks of metal, about one inch high were used to support the metal plate, and the pool filled with water so that only the upper surface of the plate was exposed, thus obtaining the maximum cooling effect from the water bath.

Water keeps heat to a minimum

Tool Cuts Time 89% in Removal Of Collector Channel Supports

AN 89% reduction in time was realized on the job of pulling collector channel supports from the kilns of TCC units at the Torrance, Calif., refinery of General Petroleum Corp. Using a simple tool, an employe can remove one support in five minutes where previous methods took 45 minutes.

The device, developed by A. J. Davis of General Petroleum's maintenance and mechanical department, is shown in the sketch below, Fig. 1:

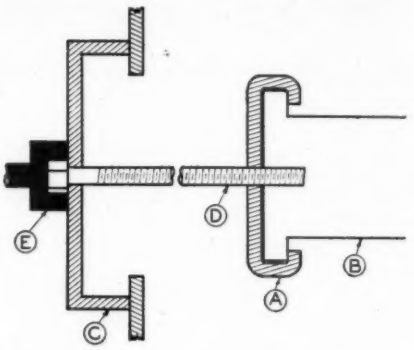


Fig. 1—Tool for removal of collector channel supports from TCC kilns

It is made up of three parts: A steel jaw, (A), which fits around the edge of the collector channel support, (B), is fabricated with a threaded hole in the center. Two pieces of channel iron about 12 in. long are welded together lengthwise and a hole drilled through the center of the piece so formed, (C). A threaded bar (D) about 18 in. long by 3/4-in. diameter, with a hexagonal nut welded on one end is the connection between the steel jaw and the channel iron piece.

In operation, the bar is screwed through the channel piece (C) and into jaw (A), which in turn is fitted over the collector channel support (B). An air motor with a socket (E) on the drive end is placed over the nut on the end of bar (D). The rotation of the motor quickly moves the jaw and the channel support from the kiln.

Previously the supports were burned loose, pried with a "come-along" or pulled with chain blocks.

Question:

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Your operating costs are extremely low with this thoroughly modern yet simple process.

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NEW VESSEL DIVISION HEADQUARTERS. Paint is scarcely dry on new air-conditioned building (above, center) which puts administration, sales, engineering, drafting, production control, and inspection immediately adjacent to the A. O. Smith vessel shops, Milwaukee.

TOO BIG FOR THROUGH RAIL SHIPMENT, four 16′ x 90′ coke drums were moved to location on Lake Michigan's biggest barges, two vessels to a barge. To get the vessels from A. O. Smith shops to the Lake Shore dock, special arrangements had to be made on five miles of railway track.

THESE SULFUR CRACKS are dangerous in welded heavy sections. A. O. Smith metallurgists have figured out a way to avoid them by controlling the residual sulfur in welding wire.

ORCHIDS to the production-control crew, headed by a twenty-five-year A. O. Smith man, who were responsible for keeping to a schedule the simultaneous production of four large 16′ x 90′ alloy-lined coke drums, a feat few shops in the world could accomplish.

Simple Shaft Straightener Frees Lathes for Other Refinery Jobs

By GEORGE CUNNINGHAM, Socony-Vacuum Oil Co., Inc., Lubrite Division, East St. Louis

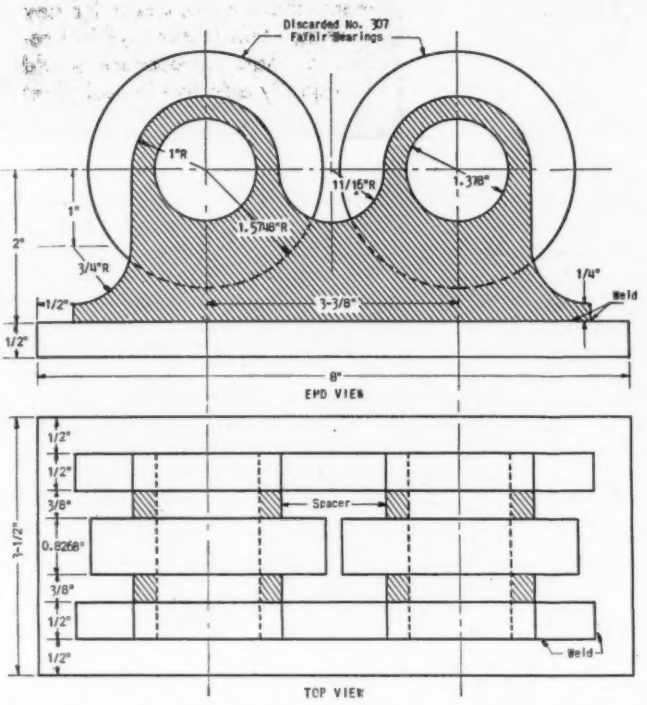

Fig. 2— Detail of shaft straightening rolls. Frame is welded ½ in. steel plate. Rolls are discarded Fafnir No. 307 bearings and are used in pairs

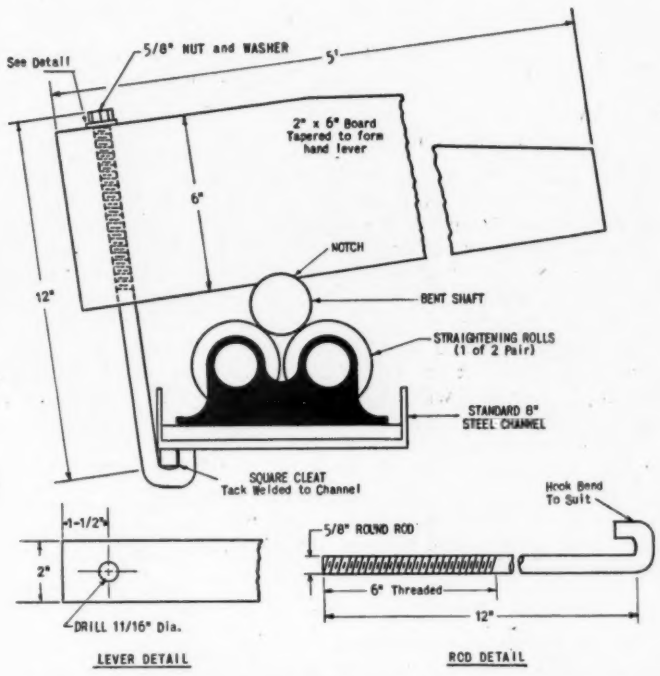

Fig. 3—Rolls and lever assembly used in straightening bent shaft or pipe. Detail drawings show 2 x 6 in. wood lever and ⅝ in. rod

A METHOD for straightening bent shafts, developed at the East St. Louis refinery of Socony-Vacuum Oil Co., Inc., Lubrite Division, has freed the usually busy machine shop lathe for other more particular work.

The straightening equipment can be constructed out of shop odds and ends for little actual material cost. It can be used as a permanent shop jig or set up as needed.

The device consists of a straight channel beam 8 in. or more wide and any convenient length, two or more shaft straightening rolls, and a wood-and-steel lever with which the actual straightening is performed.

Fig. 2 is a drawing of the shop fabricated straightening rolls. They are made from three pieces of ½-in. steel plate, a pair of discarded ball bearings, and two sets of bronze spacers to prevent sidewise movement of the inner race on the shafts of the rolls. The bearings used were No. 307 Fafnir, 3.1496 in. O. D. by 1.378 in. I. D. by 0.8268 in. wide, but this size or make are not limiting.

The spacers, depending upon the accuracy of fabrication, will be about 0.375 in. thick and are the same O. D. and I. D. as the inner race of the bearing. Shaft supporting the bearing is a shrink fit, easily placed by chilling in liquid nitrogen immediately before installation. End plates of the shaft rolls are welded to the base plate.

Fig. 3 shows the wood lever as installed on the shaft straightener. A stiff steel hook attached at one end is adjustable for various sizes of shafts. The other end of the lever is tapered to make a convenient hand grip. If desired, the lever may be made from iron pipe, however this will result in an unduly heavy piece for a workman to handle and may score the surface of the shaft.

In operation, the bent shaft is supported between two or more sets of rolls spaced conveniently along the 8-in. channel, and the lever is placed at the point where the shaft is out of true as shown by a dial indicator or other means. The hook clamps on the channel beam over a cleat on the bottom to form a fulcrum for the lever, and the notch contacts the shaft.

Pressure applied on the lever will bend the shaft back into alignment. The operation may be checked by rotating the shaft on its supports and measuring with the usual shop gages. The jig may also be used to straighten pipe in sizes not exceeding 3-in. nominal.

IDEAS—Wanted!

Plant operators, foremen, superintendents—Send in your own contributions on "how we do it around our refinery." Send your money-saving and time-saving ideas to:

Plant Practices Editor
PETROLEUM PROCESSING
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Save 360 Hours of Labor Costs By Improved Valve Plug Repair

A TOTAL of 360 man-hours labor was released for other work when an ingenious machinist suggested a method for regrooving lubrication grooves on plug valves at the Humble Oil & Refining Co. Baytown refinery.

Plug valve lubrication grooves receive considerable wear and must be regrooved periodically for proper lubrication if they are to operate satisfactorily. Usually this work is done in a milling machine.

The Humble machinist proved he could do the same job by clamping the large plugs in a vise, and cutting the grooves with an air-operated chipping hammer. He stated in his suggestion that he can regroove the five grooves in each of 12 plugs by the vise-and-chipping method while the milling machine is being set up for the operation on one plug, thus saving 360 man-hours on a 12-plug job.

Even *Utopia* Takes No Chances When It Comes to Plant Fires

By FRANK J. SLUZE, Safety Director,
Ashland Oil & Refining Co.

Thorough organization and training of fire-fighting force, with vigilant maintenance of equipment, spells quick doom for any conflagration in our mythical refinery. Same procedure would be equally effective in real plant

UTOPIA Refinery management believes that the proverbial "Ounce of Prevention" is the best fireman they have in the plant. Utopia's program, however, doesn't stop with prevention. All employes are trained to act intelligently and speedily should a fire break out. An established fire-fighting procedure has been set up and all employes are made familiar with it by constant training and instruction.

Let's acquaint ourselves with the procedure. We learn right off the bat that all fire-fighting equipment is listed as to location on a fire map, copies of which have been framed and hung at strategic locations around the plant.

Refinery Divided into Zones

We see that the refinery has been divided into zones. A code of the fire signals, corresponding to the zoning, is shown on the map as well as a list of the fire equipment in each zone.

Checking further into the procedure, we learn that the fire siren is tested by sounding it every Monday at noon. We learn too that the plant fire brigades have been organized and trained, and are available around the clock. Brigade members are recruited from occupations that are on duty throughout the 24 hours. These members form the nucleus for all fire fighting activities on their respective shifts. Trained and drilled continuously, they are given hypothetical fires as problems, and use actual equipment in fighting them.

To safeguard employes not assigned to brigades, Utopia management has set up a special evacuation procedure. This program requires each supervisor to see that all his employes not engaged in fire-fighting be evacuated from the refinery by the quickest and safest route. Regular drills are held to familiarize all employes with the evacuation plan.

Equipment Inspected Regularly

Certain supervisors have been specifically assigned the responsibilities for the care and maintenance of fire equipment. Their duties include regular inspection and tests, and written reports on such facilities as: Gasoline-driven fire pumps (daily checks), lubrication of fire hydrants (monthly), maintaining full water tanks at all times, inflating tires on wheeled equipment at least once a week, and assigning and training specific employes to the operation of pumps.

Other rules require that all fire hose be tested twice a year during April and October, all inert gas extinguishers be weighed twice a year, all foam extinguishers be inspected monthly and proof established on an inspection tag attached to the extinguisher. Extinguishers cannot be removed from normal location without permission of the safety engineer. All are returned to normal location in proper operating condition as soon as possible after an emergency. All fire hydrants are tested for leaks during each freezing spell, and all fire hose is dried before replacing on carts and racks.

So much for the written program. Now, let's make an inspection of the equipment. The first thing to strike our eyes is that all fire houses are painted red, in line with color standards. We also find the houses sealed to prevent unauthorized removal of equipment.

Hose Reel House Ready for Action

Lets open this hose reel house and examine its contents. We find a hose reel cart with 250 ft. of fire hose. Attached to the cart is a play pipe with an adjustable nozzle capable of throwing a solid stream or a spray, or of being shut off completely. Also attached to the cart are two coupling wrenches. On a hook on the wall are some spare gaskets for hose joints.

The bar with a leather collar attached is known as a "dead man" and is used to anchor the hose and nozzle in place when in use. Good idea—it keeps the hose from whipping about, making it safer to handle, even for one man.

We move on up the road where we notice that all fire hydrants are equipped with individual hydrant wrenches. The sign on the next fire house reads "Foam Generator House." Inside, we see a foam generator mounted on a truck, and a supply of foam powder stacked in containers. Folded on the truck are four 50-ft. lengths of hose.

One end of the hose is attached to the intake side of the generator unit.

Regular periodic inspections of Utopian fire hose assures good performance in emergencies, avoids situations like this

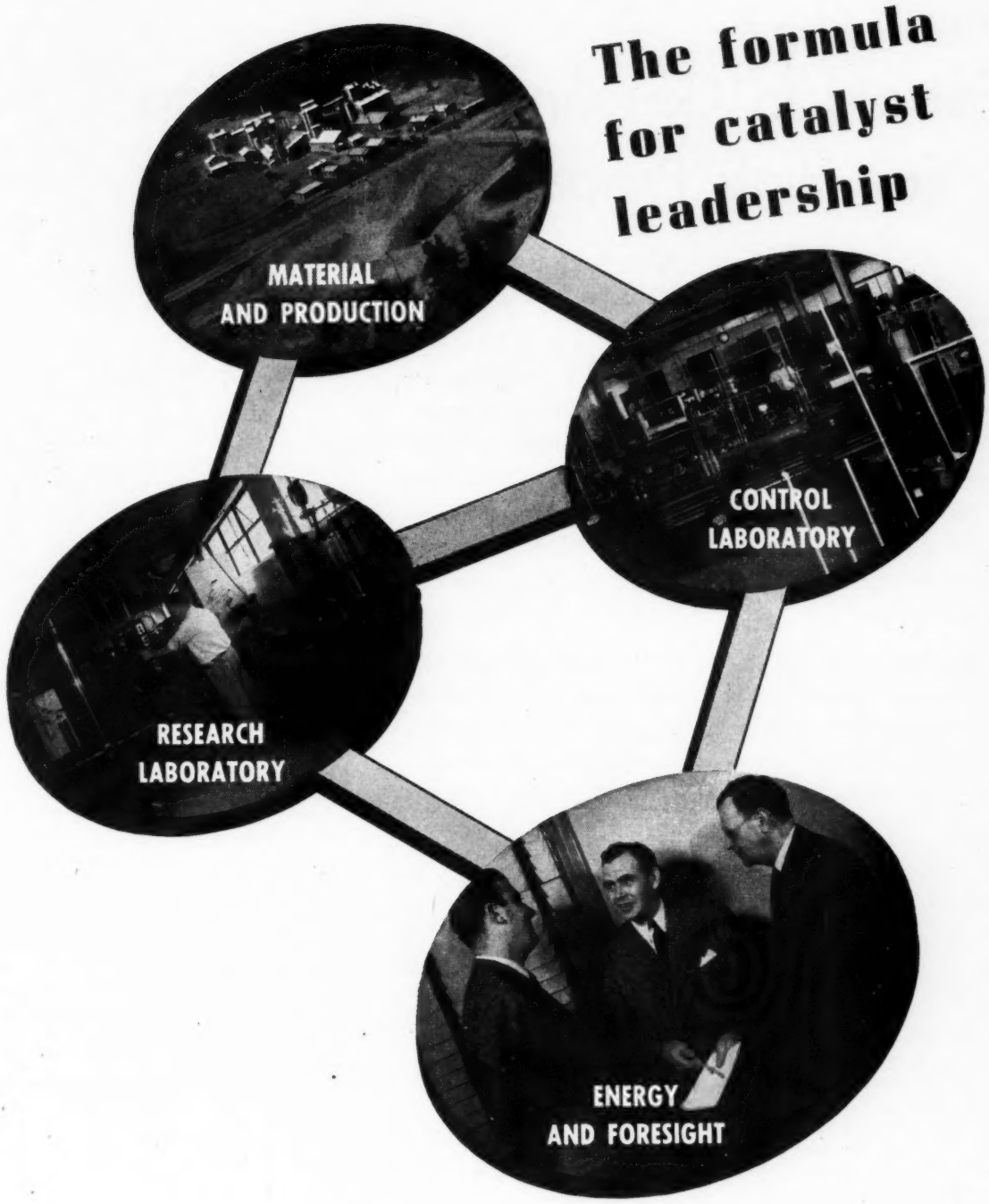
This can be unfolded and attached to the desired hydrant. Attached to the other side of the unit on a length of hose is a play pipe and open type foam nozzle.

Next we see a foam engine house containing a 40-gal. wheeled foam engine. Checking the inspection tag, we find everything in order. The house is heated to prevent freezing. An inquiry reveals that all foam type extinguishers are kept indoors sheltered from the weather. The hanging bracket for the hand type extinguishers is set so the unit can be reached from a doorway. A symbol is painted over the door so that it can be readily seen from the outside.

This phase of safety at Utopia is a large operation and we will have to continue our inspection of the fire prevention and protection facilities next time.

Certain supervisors are constantly testing Utopian fire fighting equipment as a routine matter—but NOT like this!

The formula for catalyst leadership



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Factors in Gasoline Plant Design For High Propane Recovery*

By R. E. CHAMBERS
Process Engineer, Skelly Oil Co.

Where net propane recovery of 70-80% is desired in natural gasoline plant operations, new plant design requires either additional or larger equipment, as compared with earlier installations. Additional dehydration and refrigeration equipment will operate to condense all the light vapors down to the deethanizer and there effect a closer separation of ethane from propane. Additional size equipment will include larger absorber, still and fractionators for recycling to separate the ethane into absorber residue gas.

Illustrations are given of the use of the new processes for increased propane recovery for plants handling both low and high pressure gases. Variable factors in absorber operations are given and the series of possible fractionations discussed. The functions of refrigeration and dehydration in propane recovery operations are described.

LPG manufacture was originally developed in natural gasoline plants. A few plants, in stabilizing the raw gasoline, fractionated these light overhead vapors to make propane to sell as bottled gas. An excess of butane was developed and a market was created for the butane as an industrial fuel, domestic fuel from underground tanks, and as a motor fuel.

The raw gasoline was charged either to the depropanizer and then to the debutanizer, or to the debutanizer and then the depropanizer. The depropanizer overhead was charged to a deethanizer and propane was the bottom product of the deethanizer. Flow sheets for this operation are shown in Figs. 1 and 2. In these operations vapors that could not be condensed with cooling tower water usually were vented from the reflux drums. Recompressors or reabsorbers were installed to pick up any gasoline that was being lost in these vapors, as shown in Fig. 3.

If too much ethane was picked up in the raw gasoline more propane would be lost in the vapors venting. Cooling water temperatures had a very decided effect on the amount of propane production. Butane recovery was comparatively easy. Deethanizers were installed to operate at various pressures. Those at 300 psig recovered about 45% of their feed as propane product. The same feed stock to a deethanizer operated at 480 psig gave 70% of the feed as propane product.

Dehydration was effected in the deethanizer tower even though the operating temperature in the tower did not exceed 170°F. Vapors have capacity for carrying water vapor, which determined the limit of amount of water which could be carried out the top of the tower. As long as the liquid feed had most of the mechanically entrained water settled and separated from the deethanizer charge, the propane product from the base of the deethanizer was always dry. Water condensate would collect on the upper trays of the tower and water drains on these trays were a help. About 5 to 10 gal. of water was carried over the top of the tower per 100 bbl. of overhead product. This amount of water varied with the top tower temperature. Net propane production or recovery was relatively low, usually from 20% to 50%, depending on the season of year for cooling conditions.

In recent years plants being built for propane recovery have improved to increase propane recovery to 70% to 80% design. This requires either additional equipment or an increase in size of equipment. Additional equipment will usually be dehydration and refrigeration equipment which will operate to condense all the light vapors in the reflux drums down to the deethanizer tower and there effect a closer separation of ethane from the propane and allow less

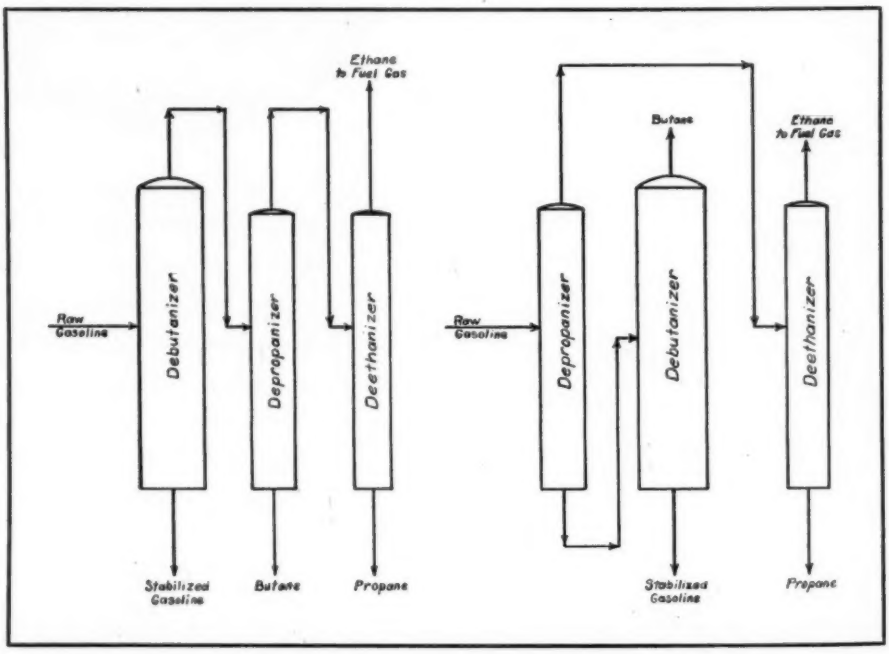


Fig. 1—(Left) Raw gasoline charged to debutanizer. Fig. 2—(Right) Raw gasoline charged to depropanizer

* Presented before Regional Technical Meeting of the Western Petroleum Refiners Assn., Alma, Mich., July 16, 1947, under the title, "Liquefied Petroleum Gas Manufacture and Bottling Operations."

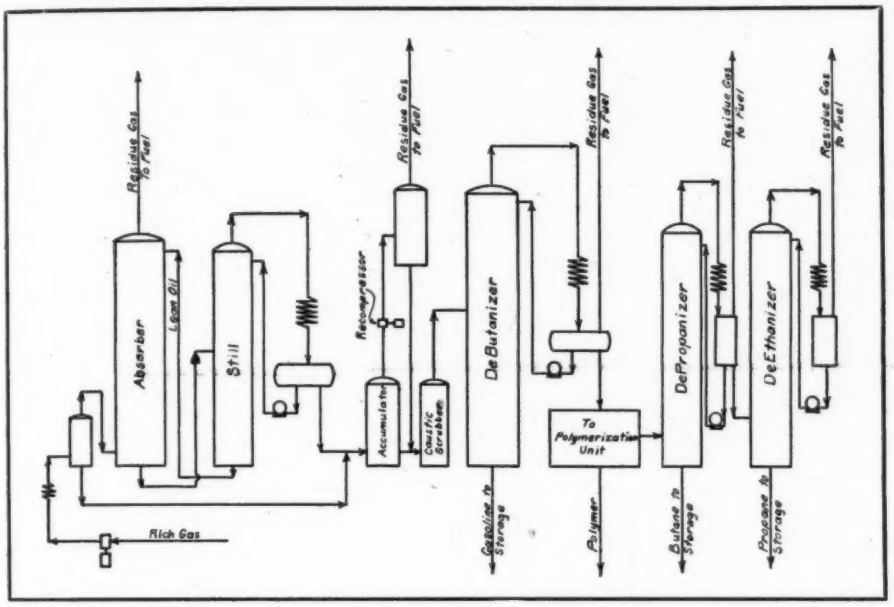


Fig. 3—Unit for recovering vapors vented from reflux drums

propane in the overhead residue gas to fuel.

Additional size of equipment will be a larger absorber or a reabsorber and larger still and fractionators to take care of the recycling vapors that result in separation of the ethane into absorber residue gas.

No attempt will be made here to promote one method over another but a brief description of the different processes and their features will be given. No attempt at omission will be made but some features of some processes may have been overlooked.

Natural gasoline and cycling plants operate their absorbers on a wide range of pressures. Cycling plants may get their gas under extreme high pressures such as 1500 or 2000 psig. This gas is comparatively lean in gasoline content. Some natural gasoline plants get their gas from the field under high vacuum and then compress it to put it through the absorbers. Examples to be given will be plants handling both low and high pressure gases as in the refineries. The absorbers will be 60 psig for low pressure and 160 psig for high pressure for the examples.

The processes depend on recovering propane in a liquid phase to separate it from the ethane and lighter components of the gas mixture. Absorption by heavier gasoline or light oil is the common method used. Whether the absorber is operated at high pressure or low pressure it is necessary to absorb the propane here if it is to be recovered as a liquid product.

Several variable factors in the absorber affect the degree of absorption. To get more propane recovery one or more of these factors would be changed as follows:

1. Increase the rate of flow of absorption oil, or increase ratio of oil to volume of gas.

2. Decrease temperature of the absorption oil to the absorber, or from absorber, or both. Intercoolers may be installed to lower the oil temperature out.

3. Reduce the molecular weight of the absorption oil. This might be limited by the degree of oil carry-over from the absorber and by the capacity of the fractionator or still to separate the gasoline and lighter from the absorption oil.

4. Keep the absorption oil clean. In systems where the same oil is recirculated a rerun still should be used to keep the oil cleaned by operating continuously on a small portion of the circulation.

5. The number of trays also may have an effect. More trays will make possible a higher degree of absorption with lower absorption factor. Modern plants are using 24 to 36 trays in absorbers for propane recovery.

6. Increase the absorber operating pressure.

The increased absorption of propane also increases the absorption of ethane. The ratio of ethane to propane remains nearly the same until a high propane recovery and then the ethane may increase in greater proportion than the propane. Methane will also be absorbed.

Most all the newer processes use one means or another to vent vapors from the rich oil, with the possible exception of some plants using refrigeration to condense all the light vapors. This venting can be done either by reducing the pressure on the rich oil or by raising the temperature. Light venting tends to let off a higher percentage of methane and ethane in proportion to the propane and butane. In some cases the pressure may be reduced two stages as in Fig. 4, for example.

These vapors are vented to the absorber or to reabsorbers or to a recompressor. The recompressor discharge is cooled and the condensate can go to the fractionation and the vapors to the absorber or reabsorbers. A large part of the ethane and all the methane should go out the top of the absorber or reabsorber on this first recycle of gas. Additional absorption oil is used to absorb most of the propane from the recycle gases and some ethane is absorbed to make a second recycle.

The rich oil after this preliminary venting then goes to fractionation. A series of fractionations can be made as shown in Fig. 3:

1. Cut the gasoline and lighter over-

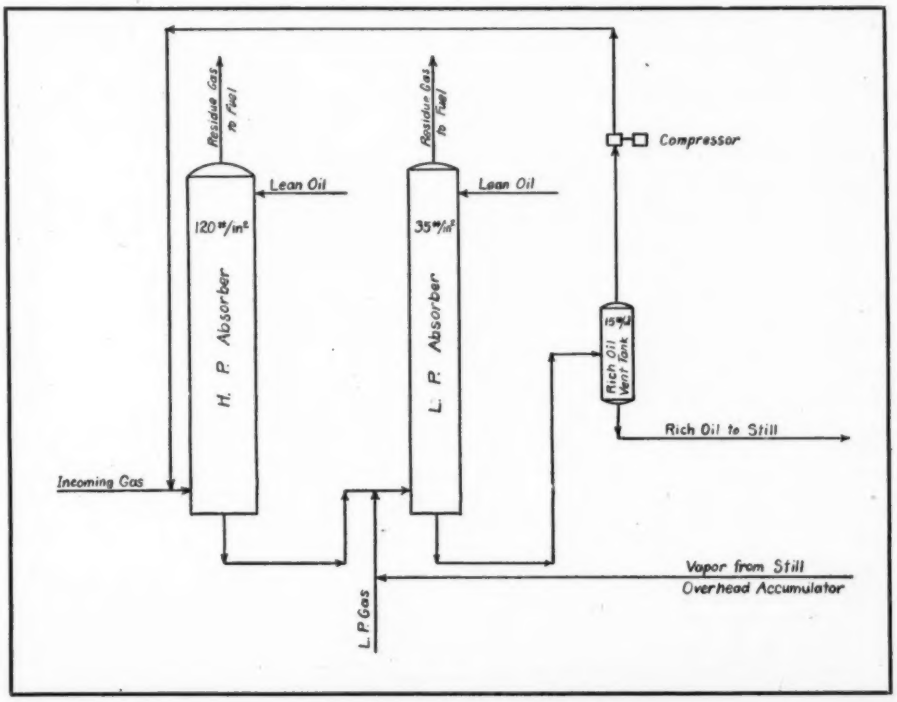


Fig. 4—Two-stage rich oil venting

head and leave absorption oil as bottom product.

2. Debutanize the gasoline.

3. Depropanize or separate between propane and butane.

4. Deethanize or separate between ethane and propane.

There can be other separations, as isobutane and so on but they are special cuts that will not be included in this subject.

These four fractionations may be done in any order. Where the same absorption oil is used and recirculated the first separation is usually the still, to separate the gasoline and lighter from the absorption oil.

If a heavy fraction of the gasoline is used as absorption oil the rich oil stream may be debutanized first and the required portion of debutanized gasoline go to the still to make absorption oil, as shown in Fig. 5. The debutanizer overhead then can be deethanized or can go to the polymerization plant. This charge to the polymerization unit should have the hydrogen sulfide removed and it can be scrubbed for mercaptan removal and then water washed to have a clean feed that will not contaminate the catalyst. If hydrogen sulfide is removed by caustic scrubbing the deethanizing operation can reduce this hydrogen sulfide content and put it into the fuel gas and thus save caustic cost and reduce the caustic disposal problem. The hydrogen sulfide content can be reduced one-half in the feed being scrubbed. There may be a little loss of propylene to residue gas and thus polymer loss. This loss should not exceed 2% of the propylene recovered.

After polymerization the first fractionation may be depropanizing or debutanizing. Deethanizing can be first but in such case there must be better stripping of ethane from the base product. The ethane percentage increases when taken off with the final propane fraction. An example analysis where the deethanizing precedes polymerization is given in Table 1.

TABLE 1—Ethane in Polymerization Feed and in Final Propane Product

	Feed to Polymerization Liq. Vol. %		Final Propane Product Liq. Vol. %
Ethane	2.0	2.0	5.0
Propane	37.0	37.0	92.5
Propylene	10.0	1.0	2.5
Butane	31.0	...	...
Butylene	20.0	...	...
	100.0	...	100.0

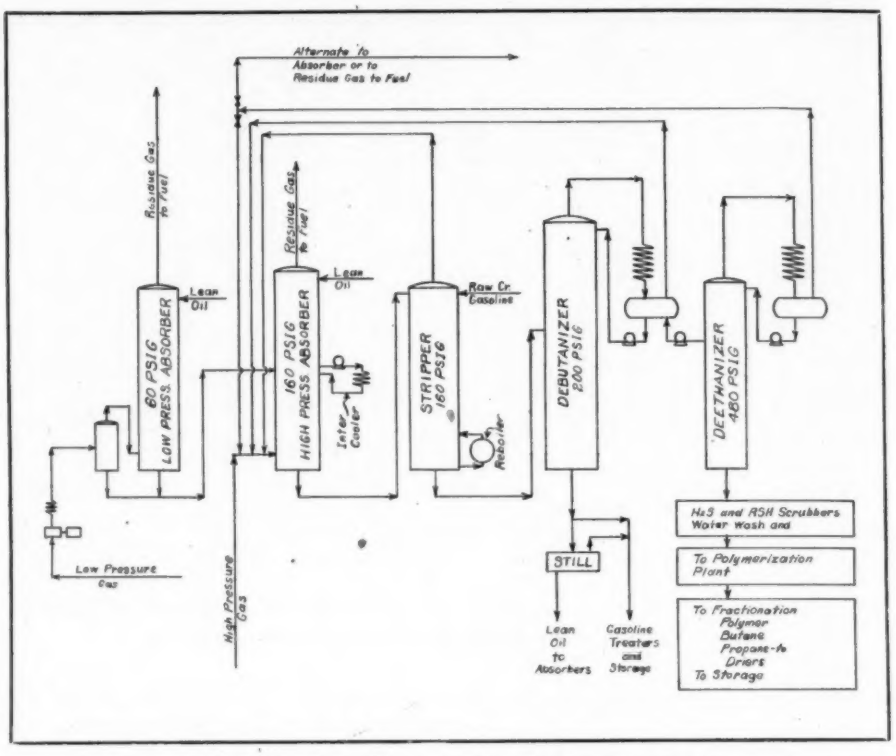


Fig. 5—Debutanized gasoline used for absorber oil, recycle vapors deethanized out absorber top.

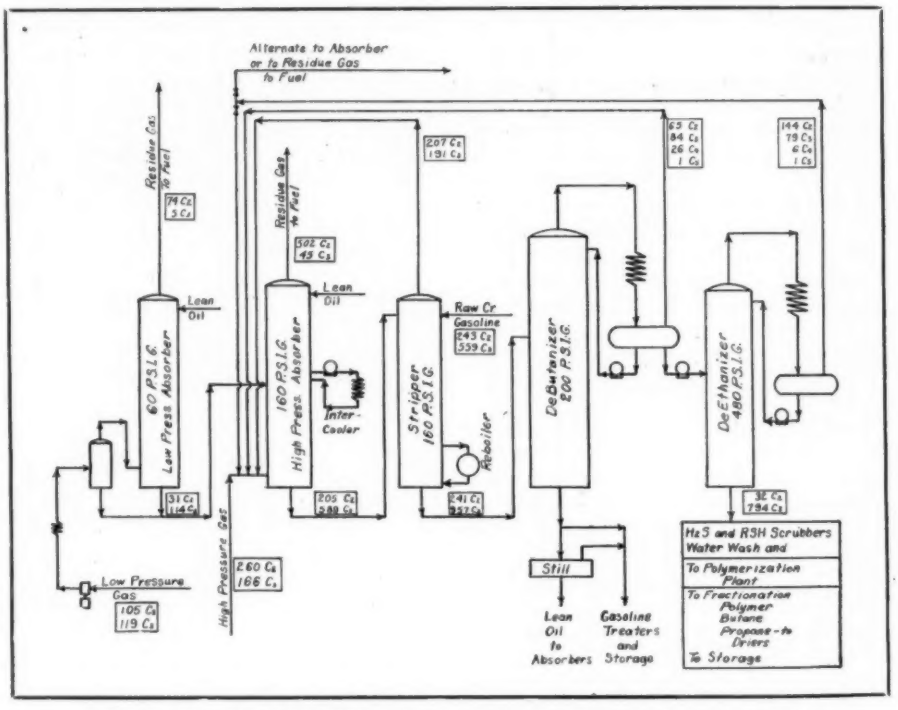

Alternate to Absorber or to Residue Gas to Fuel
Residue Gas to Fuel
79 C3 3 C4
Lean Oil
60 P.S.I.G. Low Press. Absorber
51 C3 1145 C4
502 C3 45 C4
160 P.S.I.G. High Press. Absorber
Inter-Cooler
205 C3 288 C4
207 C3 191 C4
Stripper 160 P.S.I.G.
Reboiler
241 C3 327 C4
Raw Cr Gasoline 243 C3 339 C4
DeButanizer 200 P.S.I.G.
65 C3 84 C4 26 C5 1 C6
DeEthanizer 480 P.S.I.G.
144 C3 79 C4 6 C5 1 C6
32 C3 794 C4
Low Pressure Gas 105 C3 119 C4
High Pressure Gas 260 C3 166 C4
Still
Lean Oil to Absorbers
Gasoline Treaters and Storage
H2S and RSH Scrubbers Water Wash and
To Polymerization Plant
To Fractionation Polymer Butane Propane-to Driers
To Storage

Fig. 6—Flowsheet for 90% propane recovery. Figures shown are b/d

So, wherever the deethanizing operation is located in the process it should be planned to remove the ethane so that it will be less than the desired amount in the final propane product. This would be less than 5% to just meet specification, and would allow no butane contamination in the propane.

The debutanizing following polymerization will probably be a partial debutanizing or it may be eliminated to leave the desired amount of butane to blend into gasoline. Following polymerization with debutanizing there will be the polymer, butane and propane products. The butane will go direct to storage. The propane will be deethanized if this has not been done previously. Then there will be consideration of need for drying. Some polymerization plants find it necessary to add water to the feed in amount excessive to what will settle and be carried overhead in the deethanizer. If deethanizing preceded polymerization the drying operation is necessary. There will be choice of regenerative or non-regenerative processes. Following a deethaniz-

ing tower, a non-regenerative process might be advisable.

There is a choice of drying agents, among them flake caustic, silica gel, alumina or bauxite or calcium sulfate. In the regenerative process two or three drying towers will usually be installed, to dry the propane stream through one or two towers while regenerating one tower. A third tower is extra assurance of a dry product and also allows continued operation if one tower is taken out of service for a period of time. The regeneration is a closed circulation of propane from an accumulator tank to a pump to a heater to the drying tower to be regenerated to a condenser and to the accumulator tank. A water leg is a part of the accumulator tank where the water removed is drawn off.

Propane liquid will carry from 100 to 500 ppm of water in solution so that no amount of settling is sufficient to make it dry enough to pass specification, which requires it to pass the Cobalt Bromide test. This to all practical purposes means complete removal of the water. For butane the moisture requirement is not so strict. It specifies that there shall be no mechanically entrained water. If there is good water separation of the original feed stock the depropanizer should take the moisture overhead and leave a dry final butane product. If the butane is not dry it should be cooled and given sufficient settling time and able to let the fractionation do the drying and then avoid further water contamination for butane.

In review of the processes, an example of one of the flow sheets will be taken. In consideration of LPG manufacture we will assume propane is to be made primarily. With good absorber design of 16 trays or more, 30% propane recovery will get about 95% butane recovery and nearly 100% gasoline recovery. An example will be taken of about 90% propane recovery using the flow sheet in Fig. 6 with the amounts of ethane and propane as shown in each stream. The amounts of butane and gasoline are shown only in the debutanizer and deethanizer streams back to the absorber to give the amount of recycle from these towers.

On looking at these figures it can be seen that, if the vapors recirculated could be condensed and taken through to the deethanizer and the ethane separated there and taken to fuel gas, there could be about 30% reduction in lean oil circulation. There would be less gas to the absorber and less overhead vapors from each fractionator so smaller absorber and fractionators could be used and less heat load required. Additional equipment and operation in the way of refrigeration would be necessary and dehydration of the entire vapor stream to the plant might be advisable.

The refrigeration can be done with a closed circulation of either butane or propane, preferably one or the other rather than both together.

The refrigeration might be used to chill a tank of water that would be circulated through the condensers and coolers. In this case the butane or propane would be expanded through pipe coils over which the water would be circulated. As far as I know this is untried but it might be worth consideration. In either case the refrigeration usually follows condensers and coolers cooled with cooling tower water. Care must be taken to not cool to too low a temperature where there is high pressure and water present. Hydrates may form at temperatures above water freezing temperatures in solid form to stop the flow of the vapors or liquid. The stream being cooled may be dehydrated first so that no water is present or the temperature may be maintained above the temperature for hydrate formation.

A typical flow for a refrigeration system is shown in Fig. 7. The liquid expands to vapor in the condenser or cooler. A vapor dome, or possibly mist extractor out of the top, collects the vapor to go first to a scrubber, second to a compressor, third to a condenser and finally into the top of the liquid supply tank. This supplies the liquid to the condenser. Flow is controlled by a valve to control the liquid to the condenser. Circulation continues in a closed circuit. Roughly 1000 M cu. ft. of butane vapor through the compressor would provide a system giving cooling of 1000 M Btu per hour.

For the operator wishing to convert a present operating plant to make propane or to get better butane recovery he should first determine where the butane and propane is leaving in his present operation. Analyses and volume measurements should be made if possible. If the propane and butane are leaving in the absorber residue he should consider the factors shown previously to improve absorption such as additional lean oil rate, lower molecular weight of oil or lower lean oil temperature or installation of intercooler circulation if temperature rise through the absorber exceeds 20°.

Next, rich oil vapors and vapors from the still and debutanizer and depropanize reflux drums can be taken to a recompressor or reabsorber or returned to the absorber, if its capacity permits, or the vapors may be recompressed and cooled and the condensate charged back to the still or debutanizer, or refrigeration of these overhead reflux drums might be considered. If these cannot be done then possibly the degree of absorption might need to be reduced to the point where the overhead streams can be condensed and charged to the next tower.

A deethanizing operation would need to be installed in which the depropanizer overhead would be charged. This should be designed for about 480 psig operating pressure. Provision to draw water off the top trays might be advantageous. Any provision for adequate water settling from the feed and pumping the feed from above the bottom of the accumulator will help. The reflux for the deethanizer should also be taken from above the bottom of its reflux drum and a water leg to draw off water installed.

If there is question of excessive water

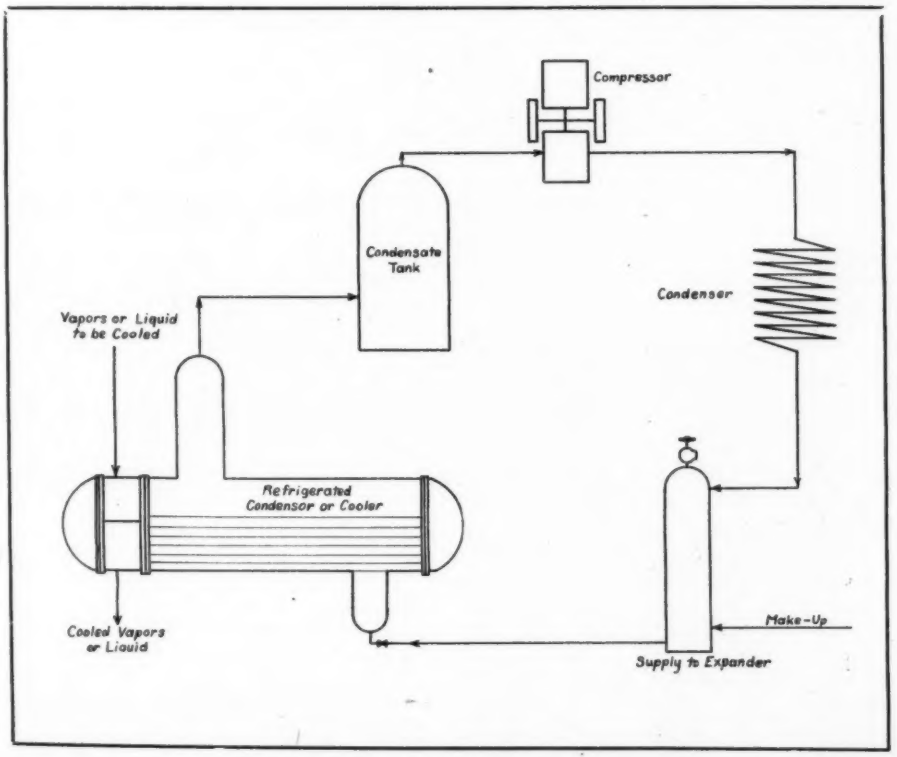


Fig. 7—Refrigeration flow sheet

to the extent it might be present in the bottom propane product in any amount then a dryer should be installed for the stream going to storage. A non-regenerative drying tower might be sufficient in this case. If water is added to the polymerization feed and adequate settling is not provided before the deethanizing then there would possibly be frequent changing of the drying agent. This would bring up the question of a larger settling drum ahead of the deethanizer or a regenerative drying system. If too much emphasis or repetition appears to have been made of drying propane it is because of its importance to satisfactory operation of propane in domestic fuel use.

A stenching operation is recommended, or required by law, providing that propane or butane for domestic use be stenched or odorized to indicate positively by distinctive odor the presence as gas in the atmosphere of about 1/5% of propane and 1/3% of butane. Different odorants are added in very small amount. Usually the odorant is foul smelling so that a leakage of gas will be objectionable but it must not give any odor after combustion. This odorant may be added to the stream going to storage or in the storage tank or in the loading line.

For the pipe lines for transporting propane or butane welded joints and flange connections are good practice with ample block valves, especially if laid through corrosive ground, as leaks in the line present a hazard not encountered with heavy gasoline and oils. The leak freezes the moisture in the ground making it difficult to get to the leak. These leaks become serious before they become apparent when buried. The corrosion will be from the soil or outside corrosion as dry propane product will be non-corrosive.

The storage should be set above ground so as to give liquid head above the loading out pump at all times. The make line should go into the bottom of the tank if large enough to hold a few days make. The tanks should be pressure equalized by opening the vapor lines to a common header. A little pressure buildup in the tanks will help out the pumping. If the tanks are small the make line should be connected to fill into the top of the tank to avoid excessive pressure buildup. In cases of filling tanks or vessels with propane or butane in short periods of time filling in the bottom causes pressure buildup as much as 75 or 100 pounds above the vapor pressure of the LPG at the average temperature in the filled tank. Filling in the top does not give this pressure buildup. The vapors in the nearly empty tank are compressed or condensed giving out energy in the form of heat. This heat will be at the surface of the liquid and in the vapors, if filling from the bottom and will give a marked temperature rise to a comparatively small amount of the total amount filling into the tank.

Storage tanks for propane should have two sample connections, one from the liquid space and one from the vapor space for moisture test. Only the liquid sample connection is needed for butane tanks. The vessels should always be vented to purge all air content before filling with LPG. This can be done during the start of the first filling. Cylinders have a few pounds of the LPG loaded into the cylinder and then this is allowed to boil off by opening the valve at the top of the cylinder.

Gauging of storage tanks in a plant or refinery can be done with reflex gauge columns. Storage tanks should always have safe allowance for expansion of the liquid. A red line painted at the gauge at 84% of full for propane and 88% of full for butane helps give a warning to the operator to never fill past those marks. Alarm signals might be advisable if the operator can not watch the filling regularly. Relief valves should be of adequate size. A combination of blowout disc and relief valve is good practice and they should be connected to a riser to at least 10 feet from the tank.

Lines from storage tanks to pumps should be of adequate size and as short as possible and should not have any rise in the line from the tank to the pump, but preferably a drop so that any vapors will tend to go back to the tank. As the liquid is pumped out of the tank the pressure drops on the tank and all advantage of liquid head may be lost. For this reason some pressure buildup by filling in the bottom of the tank may help the pumping out operation. Vertical installation is no advantage over horizontal installation in this case. Any pump installed should be sized so as to not build up discharge pressure in excess of the working pressure of the vessels to be pumped into.

Consideration must be taken of the suction pressure or 160 psig for propane and 50 psig for butane for average figures. Tank trucks are usually 125 psig working pressure for butane and 200 psig for propane. Cylinders are 240 psig for propane and tank cars are 75 psig for butane and 225 psig for propane. By filling into the top of these vessels the pressure will rise but very little above the vapor pressure of the liquid at the pumping temperature. Loading lines should be sized to not have too much pressure drop if possible. If a vessel being loaded gets full accidentally the pump still pumping should not put excess pressure sufficient to rupture the vessel.

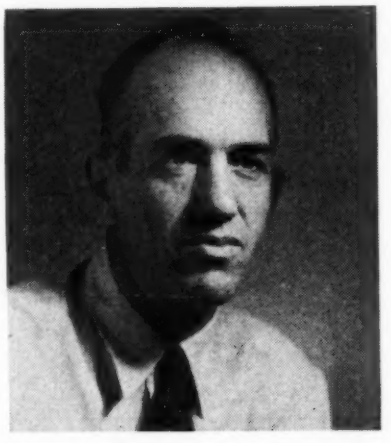
Care should be taken, however, to avoid filling any vessel, especially those being shipped, more than the allowable filling density allows. The allowable filling density divided by the specific gravity gives the percent of full a tank may be safely loaded. This is the volume at 60°F. and must be corrected for the loading temperature according to volume correction tables for the propane or butane being loaded.

Bottles are loaded by weighing on accurate scales mounted on proper foundation. Tank trucks are generally gauged by a dip tube and dial gauge calibrated in percent of full. Tank cars are generally gauged by a slip tube that is marked in inches outage from the top of the shell. Tank trucks should be grounded before connecting loading hose. An electric welding rod clamp on the end of a flexible metal cable connected to a ground spike can be connected to the truck first and not disconnected until the loading connections are disconnected.

Any vessel that has been in a fire should be retested to pass the specifications of the Bureau of Explosives for tanks or cylinders for its original rating.

All regulations and recommendations of the Bureau of Explosives and National Board of Fire Underwriters and state regulations should be studied and thoroughly understood. This especially applies to every man filling tank cars, trucks, or cylinders.

After filling the cylinders each connection, soft plugs, relief valve, and loading and outlet valve should be tested for leakage. A squirt can with soap solution is the usual means. Any leakage should be fixed before shipment or there will be a shortage when the customer receives it.



The Author

Harry E. Chambers, author of this article on the manufacture of LPG, has been associated with his subject for the past 18 years. He was graduated from Ohio State University in 1928 with a B.Ch.E. degree, and went with Skelly Oil Co. shortly thereafter. Since then he has been connected with the manufacture and development of propane and butane in natural gasoline plants, the research department, and the El Dorado refinery of Skelly.

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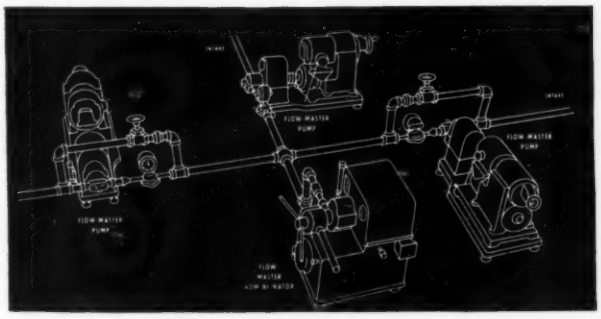

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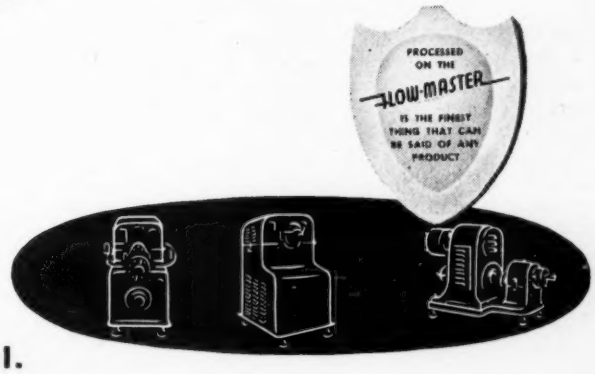

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Cut Costs on New 3000 b/d Fluid 'Cracker' By Using Unified Reactor-Regenerator

By WILLIAM F. BLAND
Engineering Editor

Small-capacity refiners today are faced with the problem of meeting the octane competition of plants equipped with modern processes—particularly catalytic cracking. In the past, such units have been too expensive for their limited economic means, but several engineering companies have recently come out with simplified designs, engineered to fit into the small refinery—both financially and technologically.

This article describes one of these new small-scale catalytic cracking units, gives details of its operation, and tells how it was integrated with equipment already existing in the plant.

THE FIRST commercial Fluid Catalytic Cracking unit built with reactor and regenerator housed in a single column was put on stream June 10 at the Detroit refinery of Aurora Gasoline Co.

The unit, which has a design charge capacity of 3300 b/d on a once-through operation at 60% conversion or 4030 b/d at 50% conversion, has been running continuously since, charging from 3500 to more than 4000 b/d of gas oil and yielding approximately 41-43% of debutanized motor gasoline. The clear octane rating of the gasoline produced is 78-80 Motor Method, and 90-92 Research Method. With 3 cc. of TEL added, the octane ratings are 85-87 Motor and 98-100 Research.

Aurora Gasoline Co. is the largest independent refiner in Michigan and the only one in the city of Detroit. Its plant processes 12,000 bbls. of crude oil daily, obtaining it by pipeline from Texas, Wyoming, Illinois and Michigan.

Upgrading Method Needed

Early in 1946 Aurora's management recognized the need for catalytic cracking or some other method to place the company in a favorable position to meet rising gasoline octane specifications.

A few months earlier, Universal Oil Products Co. had announced an improved design of the Fluid unit,* in which a single self-supporting column housed both the reactor and regenerator, rather than using the conventional steel structure supporting separate vessels side by side.

Aurora was impressed with the simplicity of the new design and was the first refinery to contract for one of the units. Although UOP handled the engineering of the job, actual installation was done by Aurora's own construction department with Universal's technical supervision.

Main design features which UOP engineers claim are largely responsible for keeping costs on the new unit well below those for wartime catalytic crackers include:

(1) Elevation of the reactor above the regenerator. This change permits transferring catalyst from the stripper directly into the regenerator. This eliminates the air riser, operating hot and requiring large expansion joints.

(2) Support of reactor on the regenerator by means of a skirt. This permits the elimination of the stuctural steel support, and requires only the light steel for stairway and access walkways. No elevator is installed in the new unit.

(3) Use of more microspherical catalyst, which together with more efficient cyclone separators makes a Cottrell precipitator unnecessary.

(4) Operation of the regenerator at 15 to 18 psi pressure, which permits smaller regenerator and smaller air lines. lines.

(5) Direct connection of the air preheater to the regenerator, which eliminates a hot air line with its expansion joints.

Existing Equipment Kept Costs Down

As in every case where a refiner with a small-capacity plant is interested in converting to catalytic operation, Aurora wanted to use as much existing equipment as possible to keep costs down.

Prior to the conversion, Aurora operated, among other equipment, a 2-coil thermal cracking unit and a thermal reformer, with a suitable recovery section. Gas oil feed for the thermal cracker and naphtha for the reformer were sup-

TABLE 1—Net Yields from Aurora Fluid Catalytic Cracking Unit
6-day average for July 12-17

	B/SD	Percent of Fresh Charge
Charge, fresh	4030	100
Fuel oil recycle	800	...
Fuel gas	...	2.0 wt.-%
C_3 recovered (LPG)	165	4.1 vol.-%
C_4 recovered	381	9.5 vol.-%
Gasoline	1692	42.0 vol.-%
Heating oil	1278	31.7 vol.-%
Fuel oil	657	16.3 vol.-%
Carbon	...	4.7 wt.-%

TABLE 2—Properties of Products from Aurora Fluid Cracking Unit

	Fresh Charge	Gasoline	Heating Oil	Fuel Oil
Gravity, °API	29.9	60.6	31.1	26.6
RVP		6.7		
Total sulfur, wt. %	0.58	0.06	0.36	0.57
Aniline point, °F.	184.3		130.5	167
Viscosity, SUS @ 100° F.	75.0		35.8	55.4
Flash (PM) °F.			184	270
Octane Numbers				
Motor Method, Clear		78		
Motor Method, + 3 cc TEL/Gal.		86		
Research Method, Clear		91		
Research Method, + 3 cc TEL/Gal.		98		
Distillation				
IBP., °F.	535	108	396	556
10%	609	134	452	610
30%	667	169	499	653
50%	711	219	532	678
70%	771	278	565	709
90%	862	352	608	766
95%	909	384	630	785
End Point		415	653	

*"New 1000 b/d Catalytic Cracker Operates on Fluid Principle," *NPN Technical Section*, Dec. 5, 1945, pg. R-939.

plied from a vacuum still in another section of the plant.

In the converted setup with catalytic cracking, both the thermal cracker and the reformer have been taken out of service and are now idle, since the Fluid unit can at present take care of all demands for quality. If at some future date octane requirements should rise above the level obtainable by blending straight-run naphtha with the catalytic cracked gasoline, the thermal reformer can be put back in service to upgrade the naptha.

Furnace Not Needed to Preheat Feed

No feed preparation furnace is necessary with the Aurora Fluid unit, since the gas oil feed stock, supplied from the vacuum still, is preheated by exchange with fractionator bottoms and vaporized by the hot catalyst when both are injected into the reactor.

The major new equipment added, of course, is the catalytic reactor-regenerator with such supplementary items as a catalyst stripper and air heater. An addition to the refinery's control room was necessary to house the instrumentation, and three new air compressors were added to supply operating and regeneration air.

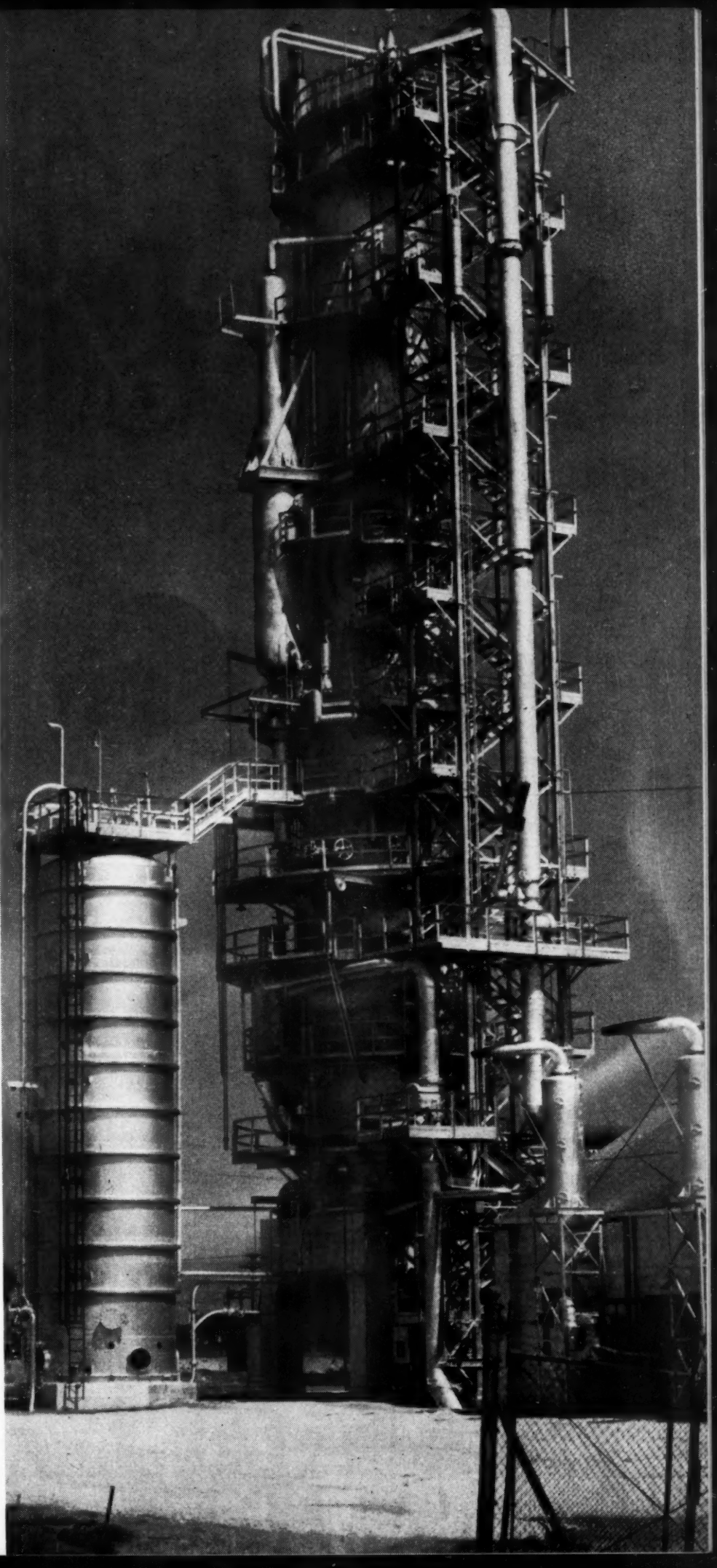
Each of the new air compressors is Diesel-driven and has a capacity of 5000 cfm. Only 7-8000 cfm of air are needed for normal operation, however, so at present the plant uses two compressors at less than full load, with the third for emergency and standby use.

The fractionation system of the old thermal units is used pretty much as it already existed, with the addition of a new side stream stripper, a new overhead condenser, and several heat exchangers. Existing pumps were used throughout, with the exception of a new column bottoms circulating pump.

Charges 29-31° Gas Oil

At present the unit is operated on a fresh charge of 3500-4000 b/d of 29-31° API gravity Ill.-Mich. gas oil with about 800 b/d recycle. Typical yields are given in Table 1, and the quality of products produced in Table 2. These figures are based on a charge of 29.9 gravity gas oil. A simplified flow diagram of the new Aurora unit is shown in Fig. 1. Flow through the unit is as follows, briefly:

Gas oil from the vacuum still is pre-



New Fluid Catalytic Cracking unit at Detroit refinery of Aurora Gasoline Co. Unique feature of design is that both reactor and regenerator are housed in a single column which is self-supporting. The low vessel to the left is for catalyst storage, and the building to the right houses the air compressors. The unit was engineered by Universal Oil Products Co.

heated by exchange with fractionator column bottoms and then picks up whatever quantity of recycle oil is being run back to the reactor. This recycle stock, which at present amounts to about 800 b/d, contains the small amount of catalyst which has carried over to the fractionator and has been removed in the slurry settler.

The mixture of fresh charge, recycle and slurry, at about 460° F., is then mixed with hot catalyst from the regenerator at 1085° F., and enters the reactor in a vaporized state. The weight ratio of catalyst circulated to oil fed to the reactor at present is about 7-9. Operating temperature in the reactor is held to 850° F.

Catalyst Withdrawn Continuously

Spent catalyst is continuously withdrawn from the upper part of the reactor dense phase to hold the level in the reactor and passes downward through the internal stripping section. It is withdrawn into the main stripper located adjacent to the reactor, and then enters the regenerator.

Catalyst passes downward through the regenerator counter-current to the regeneration air supplied at the bottom. An air preheater is used when starting up the unit, but is not required after operations are under way.

Two internally-mounted cyclones separate the regenerated catalyst from the flue gases, the latter then passing into the flue gas steam generator. When charging 4000 b/d, the unit produces approximately 8000 lbs./hr. of 140-lb. steam from the flue gas and column bottoms. The regenerated catalyst is withdrawn from the bottom of the regenerator and returned to the system at a temperature of 1085° F., as previously indicated.

Fractionator Required Few Changes

Overhead vapors from the reactor, after passing through the cyclone to remove the catalyst, are recovered in the usual manner. The fractionating tower was already existing, having been used formerly for recovery of products from the thermal operations which have now been discontinued. The only changes necessary in the tower were the replacement of a few trays because of corrosion and the installation of additional nozzles to accommodate the increased throughput and side streams.

In addition to overhead gases and bottoms, two side streams are withdrawn from the tower— a 31° gravity heating oil and a naphtha cut used as absorption oil in the plant. The naphtha stripper was already existing, but the heating oil stripper is new. New coolers were added on both side streams.

Bottoms from the tower are pumped through an existing steam generator, and are then split into two streams, one of which is recycled to the tower and the other run to the slurry settler. In the slurry settler, an old flash chamber, the last remaining portion of catalyst which carried through with the overhead from the reactor is removed and returned to the unit with fresh charge. The clarified slurry is withdrawn as fuel oil.

The vapor recovery or gas concentration unit was also existing, with the exception of one new reboiler and an additional gas compressor which had to be added.

Use Microspheroidal Catalyst

Silica-alumina catalyst is used in the plant, of the microspheroidal type. It is believed that less erosion of the equipment will result with this type catalyst as contrasted with that experienced in plants using a ground catalyst.

Catalyst losses in the unit have been exceedingly low. During the first 35 days of operation they amounted to only .24 lb./bbl. of charge—and that included a period of excessive loss occasioned when a workman used a valve control lever as a convenient hook on which to hung a bucket of insulation. The lever has since been protected against a similar mishap.

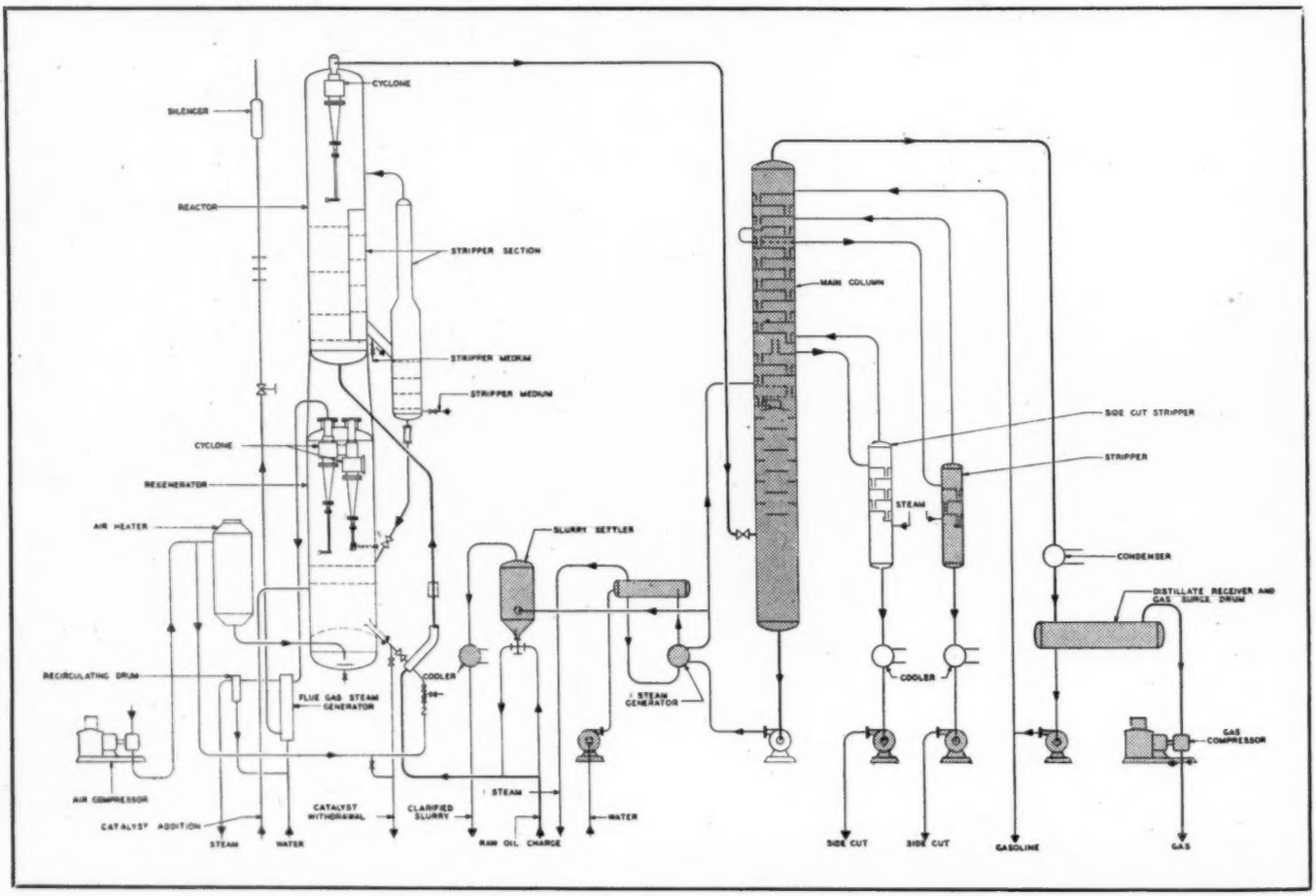


Fig. 1—Flow diagram of the Aurora unit, showing the unified reactor-regenerator section at the left and the fractionation section at the right. Those pieces of equipment which are shaded were already existing in the plant

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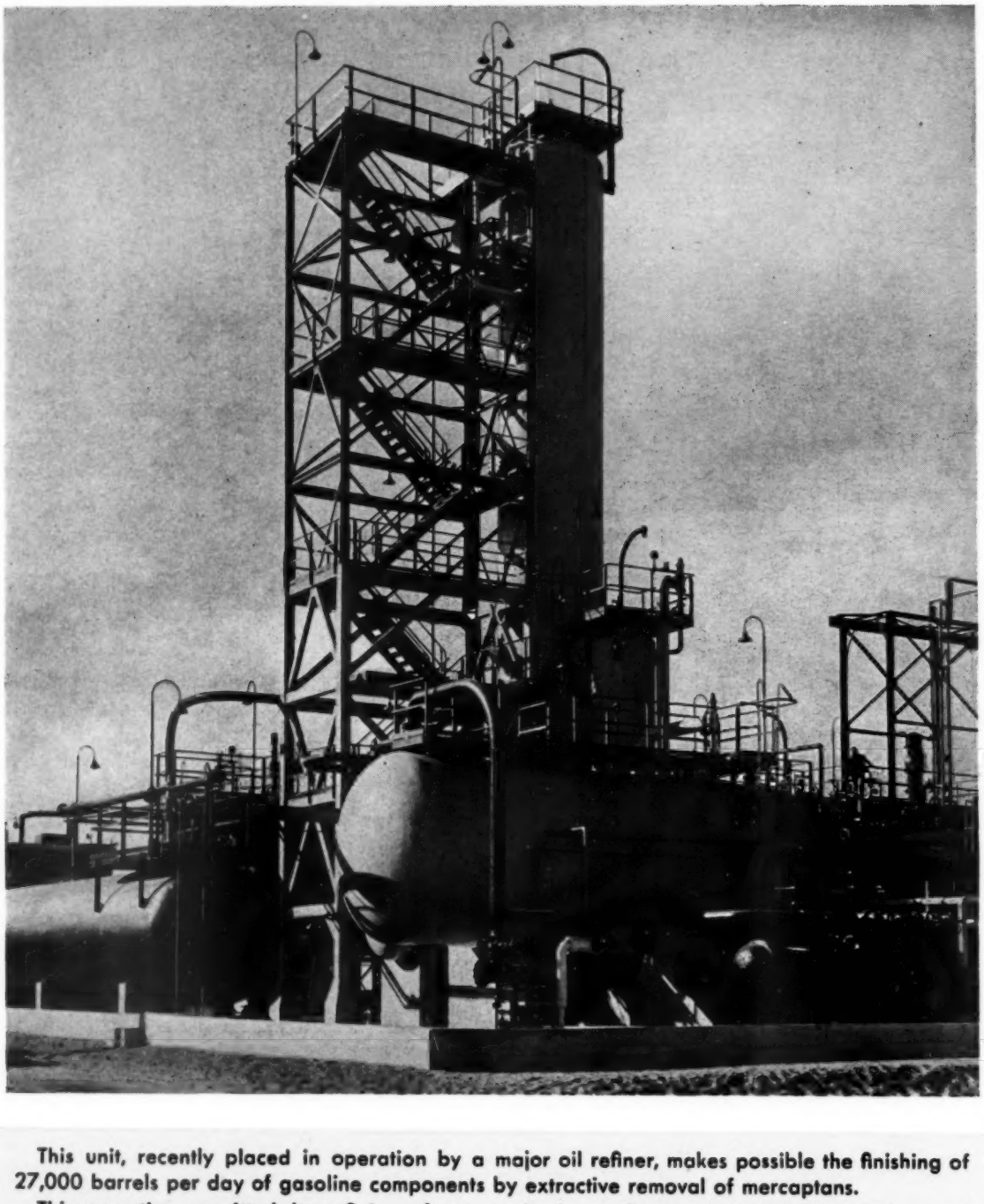

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SOLUTIZER TREATING FOR T.E.L. SAVINGS

FOSTER WHEELER

Decolorization of Petroleum Waxes By Adsorbent Percolation

By WILLIS A. JOHNSON
Attapulgus Clay Co.

Requirements for many uses of petroleum waxes today call for removing taste and odor, which can also be achieved in percolation decolorizing. Equipment for the percolation system as well as for handling and regenerating the adsorbent, is essentially the same whether oils or waxes are to be decolorized. Instrumentation requirements in the main are simple. Relative efficiencies of extruded fullers earth and activated bauxite as adsorbing materials are discussed.

Various steps in the operating cycle of a percolation filter for wax decolorizing are described. Recycling of feed stock, while economic in some instances, will require more filters than where the operation is once-through. The method used for washing the filter bed with naphtha has an important bearing on wax yield and on the volume of wash naphtha used. A recommended wash method is given. In wax percolation two phases of yield are important; volume of yield from adsorbent and percentage of yield from feed stock.

THE use of mineral adsorbents to decolorize petroleum waxes seems first to have been disclosed about 1867[1, 2]. Use of the percolation process of decolorization was probably first made in this country in the Pennsylvania region about 1890[7]. During the last two decades a number of studies of the process have appeared in the literature[3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 17, 19]. Most of these studies have been directed at the decolorization of lubricating oils and yield little information as to the application of the process to petroleum waxes. It is the purpose of this paper to furnish further information on the application of percolation to waxes.

The Petroleum Waxes

The terminology of petroleum waxes is not exact and often controversial. It is convenient, however, when defining the objectives of the percolation process, to divide waxes into three general classifications.

First is paraffin waxes. These are usually associated with the lighter distillate fractions. They are characterized by a definite crystalline form. As sent to the decolorizing system, the crystalline waxes usually have low color concentrations and are associated with only minor quantities of oil and moisture. The finished products are usually required to be white and free from taste and odor. This classification includes the grades known as crude scale, semi-refined and fully refined waxes.

A second classification is the petrolatums. These waxes are smooth, unctuous solids. At one time they were termed "amorphous." It is now recognized that the petrolatums have a crystal structure. The crystals are extremely fine and often of indefinite structure. The petrolatums are derived from the heavier distillate and residual cuts. Normally they are associated with considerable quantities of the oil from which they are derived. Their color concentration is high and relatively difficult to remove. Melting point range is approximately the same as for the crystalline scale waxes. Commercial grades of filtered petrolatum vary in color from white through amber to dark red. The lighter colored grades are required to be entirely free from taste and odor.

The third category is the microcrystalline waxes. They are the result of the more modern methods of deoiling and fractionating the heavier wax fractions, to obtain a drier product of higher melting point. Essentially, they are derived from the same cuts as the petrolatums. Principally due to better purification in processing, these waxes tend to crystallize, but in fine and sometimes malformed crystals. They are characterized by hard, tacky, pliable, impervious films. Their use as coatings, plasticizers, and compounding agents requires a wide variety of finished colors from white to very dark shades. When used with foods or household products, the finished wax must be free from odor and taste.

It can be seen from this brief summary that, in general, the decolorization step in refining the petroleum waxes should remove taste and odor as well as color.

Decolorizing Adsorbents

Although a great many materials have been considered,[14] only two types of adsorbents at present have extensive commercial use and will be considered here. They are extruded fullers earth and activated bauxite. As used, both of these adsorbents are in the granular form, the most used size grades being 30/60 and 20/60 mesh respectively.

Granular extruded fullers earth is an efficient decolorizing medium and may be reactivated a number of times. Reactivation is usually accompanied by a gradual decline in efficiency which makes it necessary to discard the adsorbent after 10 to 20 cycles and replace with fresh material. Determination of the point of discard is generally based upon economic considerations. The removal of taste and odors which accompanies the decolorization by fullers earth, does not, in all cases, reach a satisfactory level. With the extruded earth, therefore, it may be necessary to use some subsequent treatment to meet these requirements.

Granular activated bauxite in most cases gives finished wax yields as good or better, on a weight basis, than extruded fullers earth. Since the apparent density of bauxite is 1.6 to 1.8 times that of fullers earth, there is a large volumetric yield advantage in favor of the bauxite. Removal of taste and odor, to a satisfactory degree, accompanies the removal of color by bauxite.

Like extruded fullers earth, bauxite is regenerable. However, the decline in efficiency with repeated regeneration is more gradual. As a result, a point is

reached where make-up additions of fresh adsorbent just offset the efficiency decline. Thus an equilibrium is achieved at a relatively high level of efficiency which usually makes overall discard unnecessary. Under normal operations equilibrium efficiencies of 70 to 80% of new adsorbent may be maintained. In special cases, however, discard after a period of use may be economically advantageous. From both quality and economic considerations bauxite is usually the preferred choice for wax percolation.

Percolation Equipment

Whether waxes or oils are to be decolorized the equipment for a complete percolation plant is essentially the same. The chief difference for wax production lies in the necessity for providing means of holding the waxes in a fluid condition during all operations. The equipment is conveniently divided into two groups:

1. The percolation system, which deals with the decolorization operation.
2. The equipment required to handle and regenerate the adsorbent.

The Percolation System

Filters

The filter shell itself (Fig. 1) (Table 1) is a hollow, cone-bottomed, steel cylinder,[4, 6] the top closed by a dished head. Normal filter design calls for the height of the straight shell to be at least twice its diameter. Within reason, a higher ratio is desirable. For wax a ratio of 3:1 or slightly greater is a practical optimum. The shell should be designed for a working pressure of 50 lbs. psig. The cone bottom should have a minimum slope of 45°.

TABLE 1—Standard Filter Shell Capacities

Diameter Ft[1]	Depth Ft[1]	Cubic Ft[1]	Charging Capacity Tons Fullers Earth	Bauxite
6	15	425	7	11
8	20	1000	17	27
8	25	1250	21	34
10	20	1570	25	40
10	25	1960	32	51
10	30	2350	38	61

(1) Measured on the straight cylindrical shell.

Manheads, top and bottom, are centered on the vertical center line. The top dished head is flanged to receive feed, air, steam, and wash naphtha lines. The top manhead is of conventional construction, provided with a try-cock vent. The bottom manhead is of the self-dumping[6] type which allows ready discharge of spent adsorbent. (Fig. 2).

The filter shell is normally supported by brackets from appropriate steel work so that the bottom head and outlet piping are easily accessible to the operator from floor level. Conventionally, filter shells are arranged in two parallel rows served by a common conveyor system. With only a few filter shells, conveyor requirements can be reduced by arranging the filters around a central elevator and charging regenerated adsorbent directly therefrom.

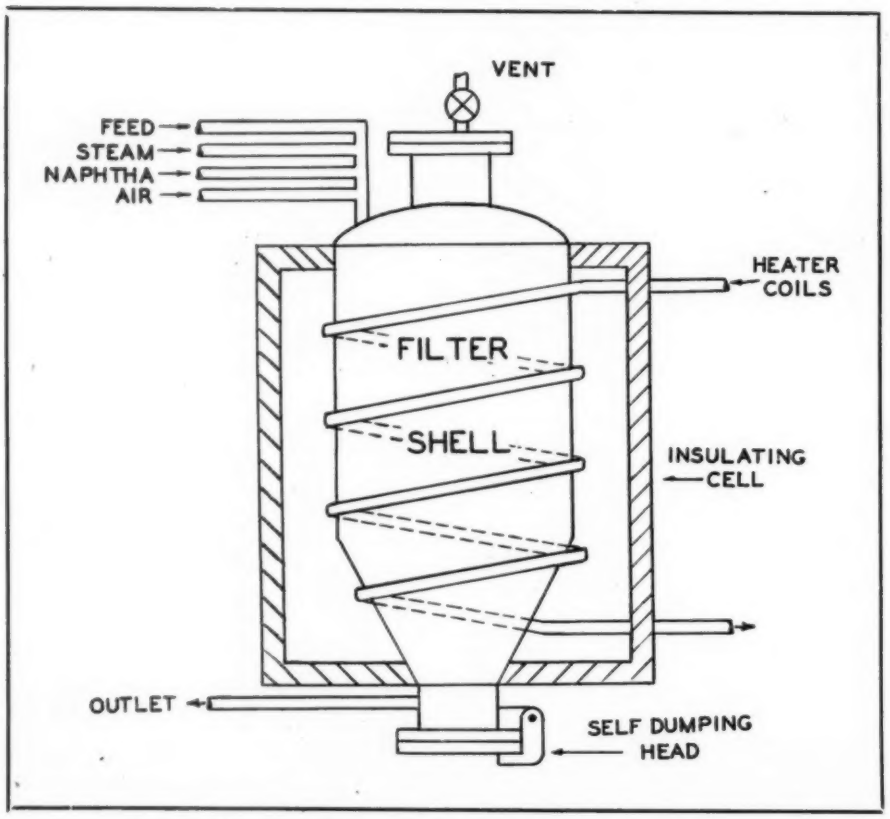

Fig. 1—Filter shell of percolation system for decolorizing waxes

Each filter should be housed in an individual, insulated cell. In the annular space between inner wall of the cell and exterior surface of the shell are heating coils. The space should be sufficiently large to allow for maintenance and repairs to shell and coil surfaces. Purpose of the cell and coils is to maintain the filter at operating temperature without substantial heat losses from the filter bed.

A substitute type of construction is the use of individually lagged filters. However, this is felt to be less efficient and more costly to maintain.

Piping

All piping which carries wax, or wax bearing products should be manifolded to avoid contamination of feed with water or wash naphtha. Any piping used in common by naphtha, feed and steam should be arranged to purge itself during the steaming operation. This is also true of outlet piping. Here provision for purging is made with the recommended type of bottom head. Inasmuch as the outlet flow is controlled, feed lines to filters operating on a single product may be a loop system. This allows each filter to "take" what it needs. Excess over the filter "take" is returned to pump suction.

Feed Distribution

No special means for feed distribution is necessary. A splash plate on the top of the adsorbent bed gives all distribution necessary, and prevents excessive displacement of the bed. Valving should be specified with the knowledge that occasional screen breaks may bring granular adsorbent into the lines. Double valving is good practice. A back pressure relief valve on the loop feed line is desirable.

Pumps

Pumps are required for feed, wash naphtha, filtrate and wash stocks. The number used in any given system depends on convenience and the importance of any cross contamination of products and feeds. Since all pumps are discharging to low pressures, the type of pump selected is not critical and depends on preference.

Tankage

Tankage for feed and product should contain sufficient heating coil surface to maintain stocks in a pumpable condition. A feed heater is desirable for controlling filtering temperatures to optimum values. Filtrate receivers should be heated and of sufficient capacity to hold the entire filtrate yield from one filter. Their number should at least equal the maximum number of filters which will be on stream daily. Size of feed tanks and product storage conforms to plant operations. Inside unroofed storage is desirable for finished products.

Regeneration System

The regeneration system centers around the kiln, where the adsorbent is

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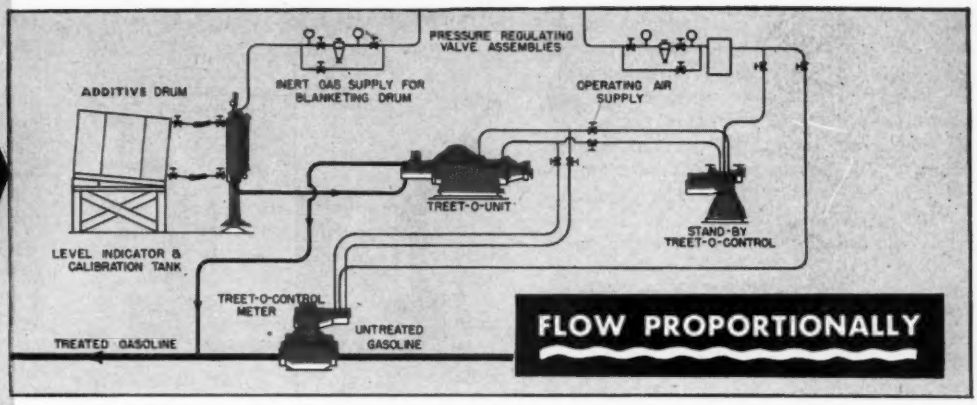

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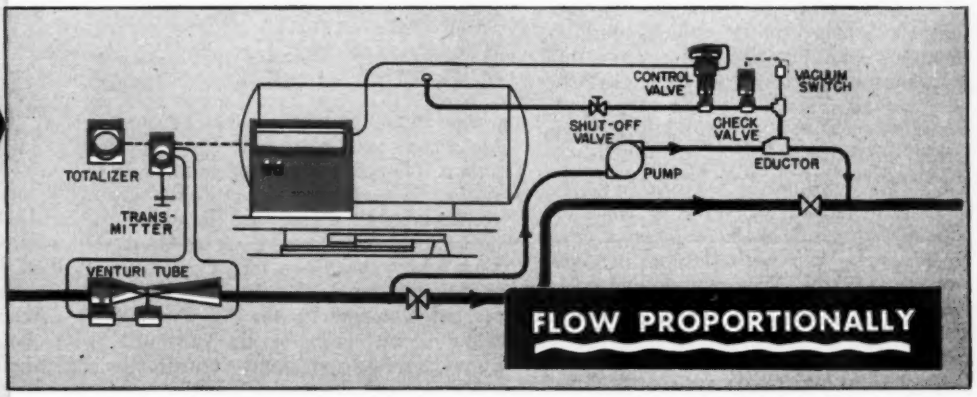

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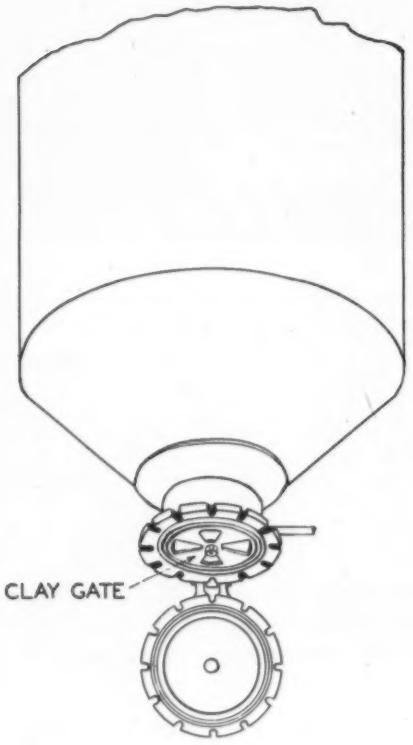
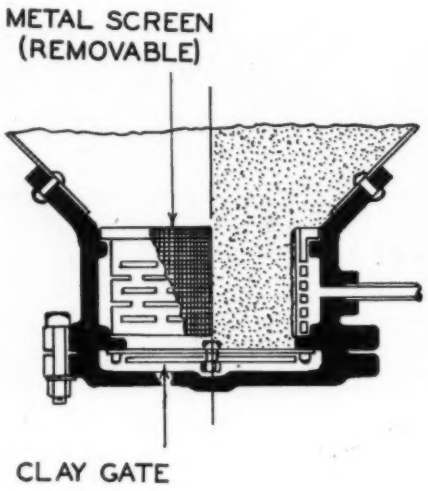


Fig. 2—Self-dumping filter head for percolation filters



tempered and regenerated. Several types of kiln are available, including the rotary, (Fig. 3) Thermofor, (Fig. 4) and multiple hearth all of which are available in several throughput capacities. (Fig. 5) The chief requirement of the kiln is its ability to regenerate the adsorbent under closely controlled temperature conditions. The close control of burning temperatures is essential in maintaining the adsorbent at highest efficiency.

Coolers

It is generally necessary to cool the adsorbent to safe belt temperatures as it leaves the kiln. Several types of coolers are available. They include coil coolers installed in hearth type kilns, rotary coolers both air and water cooled, tubular coolers and gravity flow baffle air coolers. The latter type are usually lowest in cost and are efficient and controllable.

Accessory Equipment

Accessory to the kiln are the conveying, adsorbent storage and adsorbent conditioning steps. Conveyors and elevators handle spent and regenerated adsorbent. Endless dished belt conveyors and continuous overlapping bucket elevators are recommended. Screw conveyors and pneumatic or other mass flow systems frequently tend to pulverize the adsorbent. If one of the latter systems is used great care must be taken if adsorbent losses are to be kept low. Adjuncts to the conveying system are hoppers to discharge spent earth to the belt and trip chutes for returning regenerated material to the filter shell.

Bin storage for adsorbent should be principally on the inlet side of the kiln. Only surge space should be provided on the outlet side. Shape and size of storage bins are determined by space and convenience requirements. Cone bottoms should have a minimum angle of 45°. An angle of 50° is considered optimum.

Wash System

The wash system consists of storage for clean and spent solvent naphtha, means for recovering wash naphtha from wash and a receiver-decanter for steam condensate. To this should be added appropriate pumps and piping and a clean naphtha heater-cooler. Conventional wash recovery units vary from the simple batch steamer to the continuous distillation unit. Probably the best unit is a simple flash stripping tower which utilizes tail steam from the filters. This tower has heater and reboiler units and provision for additional exhaust or other steam. Continuous operation allows the return of a large part of the recovered wax to the system at approximately feed stock quality. The solvent naphtha heater-cooler is a simple heat exchanger for the regulation of wash temperatures. Condensers are required for the wash recovery unit or to handle steam from the filters if continuous reduction is not used.

Instrumentation

The instrumentation of a percolation system is simple. Flow meters and a record of temperatures should be provided on filtrate outflow lines.

Elaborate flow recorder-controllers and recording thermometers are seldom justified. The rotameter makes a good flow rate indicator and provides a visual inspection of the filtrate stream. Indicating thermometers or thermocouples fulfill the temperature requirements. A temperature recorder-controller is justified on wash naphtha. Complete multipoint temperature records are required for the kiln.

Operating Cycle

The operating cycle of a percolation filter consists of the following steps:

1. Charge with adsorbent
2. Fill with feed stock
3. Soak
4. Run to specification color
5. Run to recycle stock
6. Drain
7. Wash
8. Steam
9. Dump

1. Charge with adsorbent.

Prior to charging, the adsorbent has been treated in the kiln. New adsorbent is tempered at 750° to 800° F. before use. Spent adsorbent is regenerated at 1050° F. to 1100° F. These temperatures are optimum whether fullers earth or bauxite is used. From the kiln, the adsorbent is passed through a cooler where its temperature is adjusted to the desired level. This adjustment should be such that the adsorbent goes into the filter at a temperature no lower than that at which the subsequent filtration is to be conducted. The upper limit of temperature is, of course, that which the conveyor belt will withstand, usually

TABLE 2—Running Rates for Wax Percolation Filters

Approx. A.P.I. Gravity	Approx. Vis. 210° F. S.U.	Filtrate Take Off Rate Bbl./ton/hr. Fullers earth	Filtrate Take Off Rate Bbl./ton/hr. Bauxite	Approx. Oper. Temp. ° F.
43	36	2.0–2.5	1.5–2.0	160
42	38	1.8–2.2	1.2–1.5	180
40	43	1.5–2.0	0.8–1.0	180
38	50	1.2–1.8	0.6–0.9	200
35	75	0.9–1.5	0.5–0.8	210
33	95	0.7–1.2	0.4–0.7	210
30	110	0.5–0.9	0.4–0.6	210

about 250° F. The introduction of hot adsorbent into the filter is important. The low coefficient of thermal conductivity of either type of adsorbent makes it uneconomic to attempt to heat the bed by means of the external heating coils.

The rate at which adsorbent is charged to the shell is purely a function of the conveyor capacity but in most cases is from 3 to 4 tons an hour. No tamping or packing other than gravity fall is necessary. When the adsorbent charge is complete, the upper surface of the bed is raked level and the splash plate put in place. The filter is now ready for operation.

2. Fill with feed stock.

If not already so, the filtrate take-off is opened. The top manhead is left uncovered. With the splash plate in place, feed stock is started onto the filter bed, as soon as possible after the adsorbent is in place to prevent heat losses and the adsorption of moisture from the air. Prior to introduction, the temperature of the feed stock should be adjusted to the predetermined operating temperature. Once the feed is started the top of the filter bed should remain covered with charge stock at all times. This forms a hydraulic seal which expels the bulk of the air from the filter ahead of the advancing liquid front, and aids in the prevention of channeling by rising air bubbles.

The open top head serves as a vent for by-passed air and allows the operator to observe the rate of soakage. Filling is continued until wax "shows" at the filtrate outlet. The bottom outlet is then closed and the filter is allowed to soak. 5 to 6 barrels per ton will be required to fill a bauxite filter. For fullers earth 8 to 9 bbl. per ton are required.

3. Soaking.

After filling with feed stock, time is allowed for the filter bed to settle and any unexpelled air to work out. This is done with the top manhead still open. Usually one hour is sufficient soaking time. The run should not be started, however, if air is still being evolved Thirty minutes additional time should be allowed, after air has ceased evolving, before the run is started. This precaution allows full settling of the bed, to prevent channeling.

4. Run to color.

At the end of the soaking period, the top manhead is secured in place and the charge pump started. Air displaced from any free space above the liquid in the filter is vented from the try-cock in the top manhead cover. The flow rate of the filtrate is adjusted and maintained at the desired rate. (Table 2) Any necessary adjustments in feed temperature are also made. The run is continued at rate and temperature until the composite filtrate has reached specified color.

It is possible to take the filtrate also in several successively darker cuts corresponding to several different color specifications. This has been frequently practiced especially in the manufacture of light colored petrolatums. Usually this is more costly than the balanced recycle and single product method discussed below.

Very little pressure is required to maintain the operation at rate, merely that required to overcome the pressure drop of lines and the filter bed. Filter pressures rarely exceed 25 psig. The average is about 15 psi.

5. Run to recycle.

The recycle operation may or may not be included in the cycle of filter operations. It is only mandatory where very light filtrates are produced from highly colored feed stocks. Recycle, if properly conducted, will return the maximum yield for the minimum quantity of adsorbent. It will, however, require more filter shells than operation without recycle.

The recycle operation is based on the fact that the decolorizing capacity of the adsorbent bed is not completely saturated when the filtrate composite has reached specification color. The remaining decolorizing capacity is capable of producing a further quantity of filtrate, darker than specification, but lighter in color than the raw feed. The recycle stock so produced, if filtered again on another cycle, will (since it is lighter than raw feed) produce a larger yield of specification color. It is evident that, if the recycle feed is followed onto the filter by raw feed, another quantity of recycle stock will also be produced. The recycle operation, therefore, varies from the operation so far described in that:

a.) The filter is filled and started to run with recycle stock as the feed.

b.) After the run to color has progressed to some predetermined point, the feed is changed from recycle to raw stock.

Cuts to specified color and recycle stock, of course, continue within the same quality limits.

To meet the requirement of maximum yield with minimum adsorbent consumption, there must be an equilibrium in adsorbent efficiency and a definite balance in the recycle operation. This balance must be such that the combination of recycle and raw feed produces not

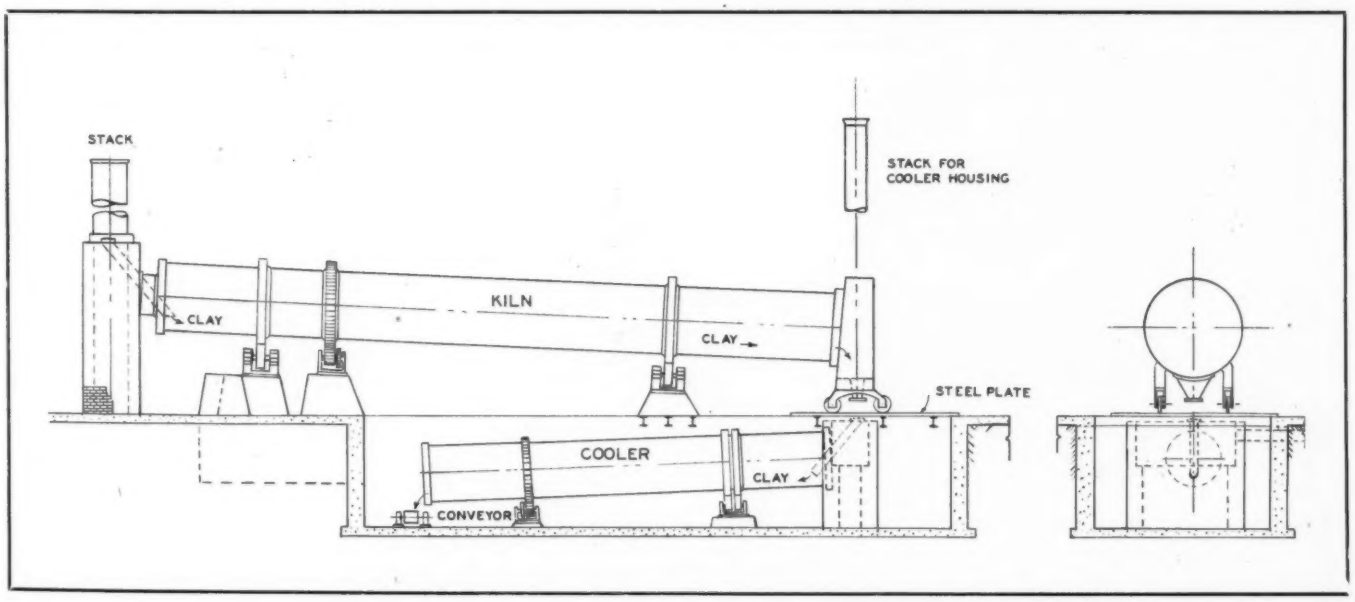


Fig. 3—Rotary kiln for regeneration of adsorbent in wax percolation decolorizing

only a larger specification yield, but also a yield of recycle stock of such quantity and quality that the specification and recycle yields will be exactly reproduced in the next succeeding cycle.

In the recycle operation, the filtrate stream is switched to another receiver when the first filtrate has reached specification color. During the recycle run conditions of temperature, flow and pressure are maintained at the same values as in the run to color. Just as with the first cut the recycle stock is run to some definite predetermined standard. When the composite has reached this standard, feed is shut off and the run discontinued.

6. Drain

When the run to product and/or recycle has been completed, charging is discontinued and the filter is drained under pressure or pump suction. Pressure draining is usually accomplished with air. A pressure of 20 to 25 lbs. psig. is used. Draining is conducted at such a rate that a liquid column is maintained ahead of the air until practically all liquid has been expelled. The drainings are returned to charge stock. Bauxite filters drain in 20-30 minutes per ton; 30 to 45 min. are required for fullers earth.

7. Wash

When the filter has been drained, the filter bed is washed with naphtha. This is to remove wax of feed stock quality which is still held mechanically on the surface and in the interstices of the adsorbent granules. Concurrently it is desired to "desorb" and segregate a portion of the "sorbed color bodies" and impurities in order to reduce the combustible content of the adsorbent to quantities which may be burned at controlled rates during reactivation.

It can be seen that this operation has considerable bearing on the ultimate recovery of specification product. To obtain the maximum possible product recovery all wash stocks of charge stock quality should be returned to feed. The manner in which washing is conducted has considerable bearing on losses of naphtha and the volumes of wash stocks which must be denuded of naphtha.

In order to obtain the proper solubility relations to allow segregation of the wash into filterable and unfilterable stocks, a paraffinic naphtha is most desirable. A satisfactory wash naphtha has the following specifications:

IBP, °F.	180—190
50%, °F.	270—290
90%, °F.	330 Max.
EP, °F.	360 Max.
Aniline Point, °C.	52
Color, Saybolt	18 Min.

While there are a number of methods of washing, the following method uses minimum quantities of wash naphtha and, when properly steamed, leaves the adsorbent in excellent condition:

The drained filter is pumped full of naphtha until naphtha shows through at the outlet. The filter is then shut in for a one-hour soaking period. Then the filter is again drained under pressure. A second wash is then put on in a similar manner. Two to three such displacement washes usually will suffice. The total amount of wash naphtha consumed will be 10 to 15 bbls./ton.[15]. Clean naphtha is used for all washes.

The temperature at which the wash naphtha is used is of considerable impor-

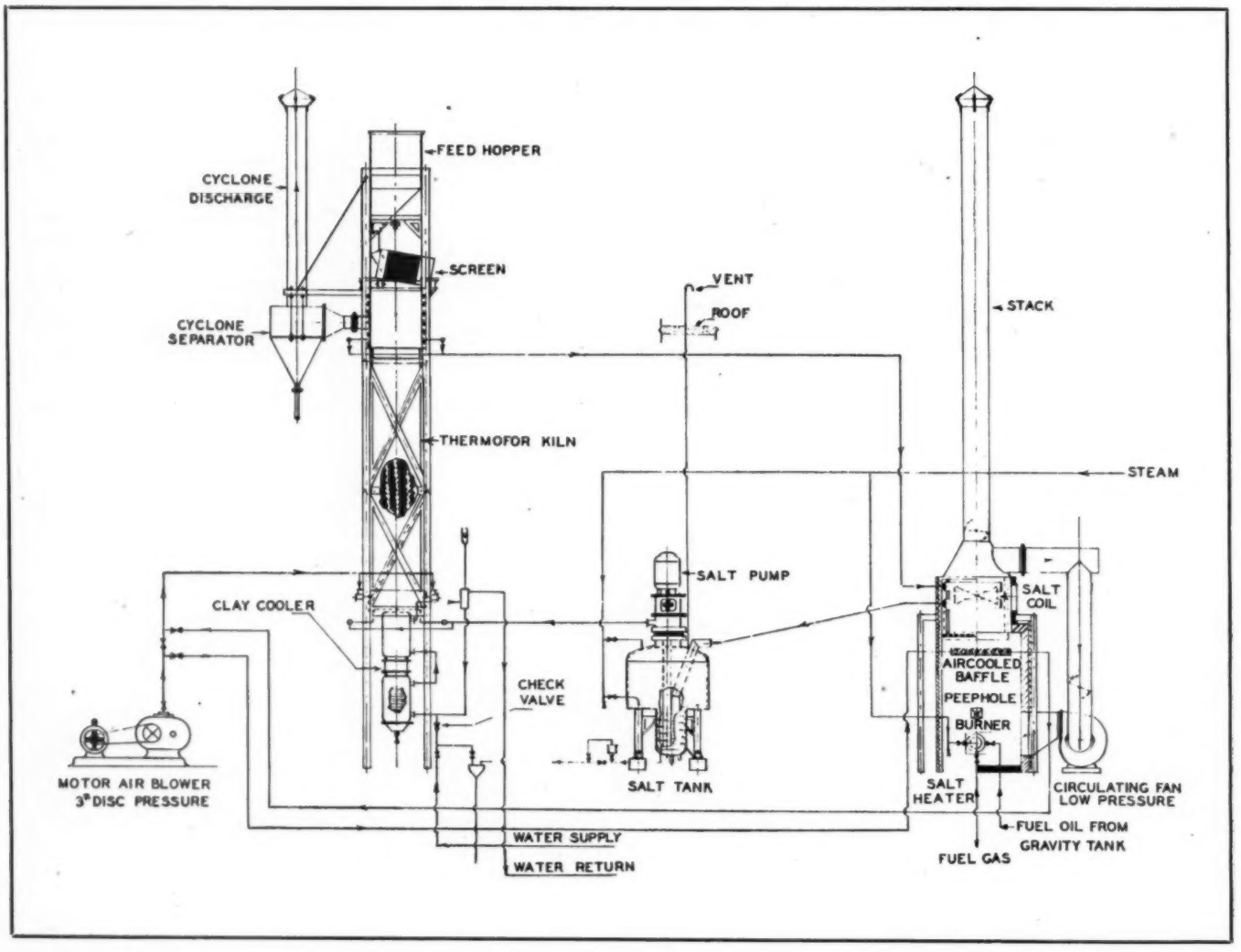


Fig. 4—Thermofor kiln for regeneration of adsorbent

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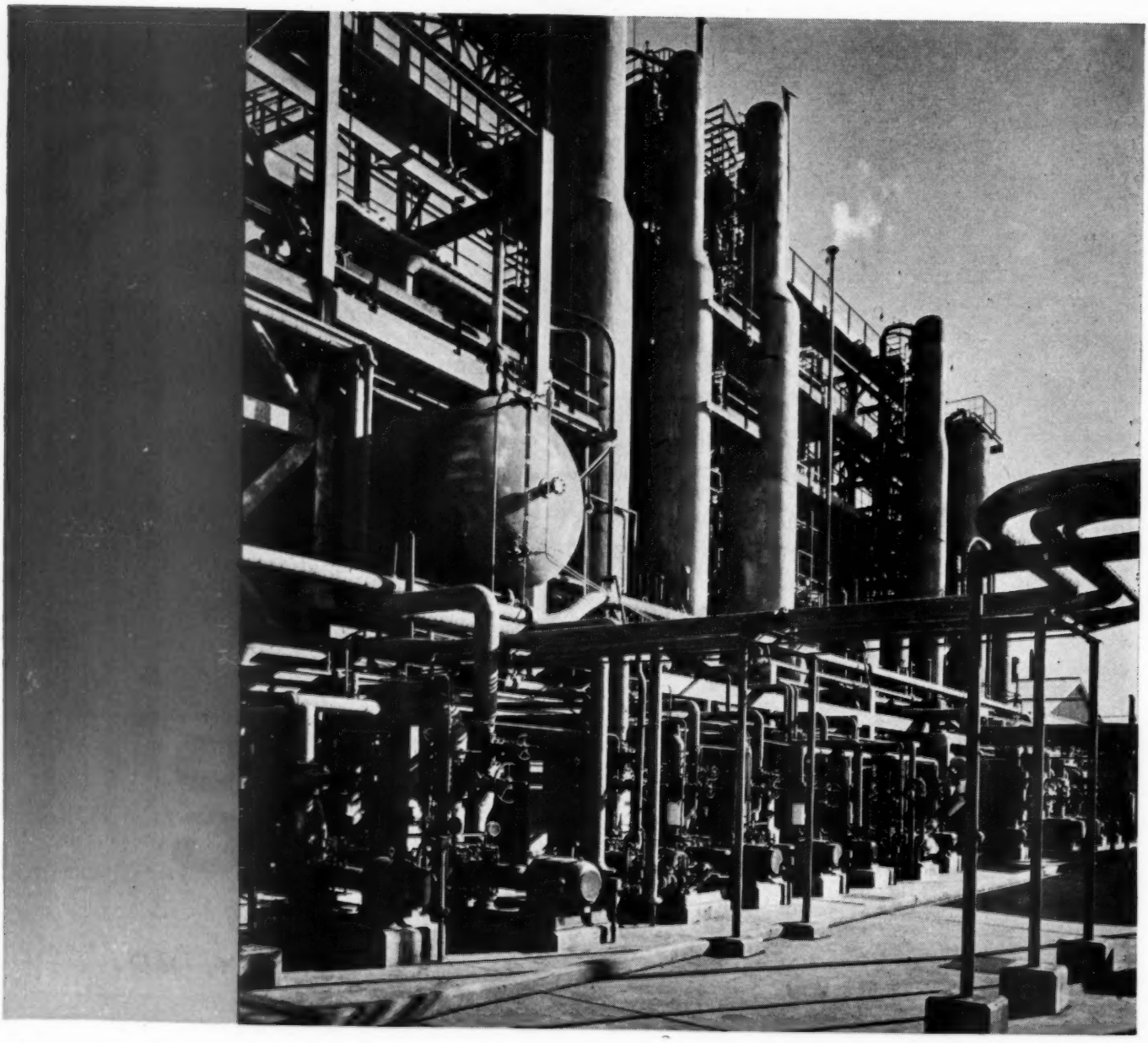

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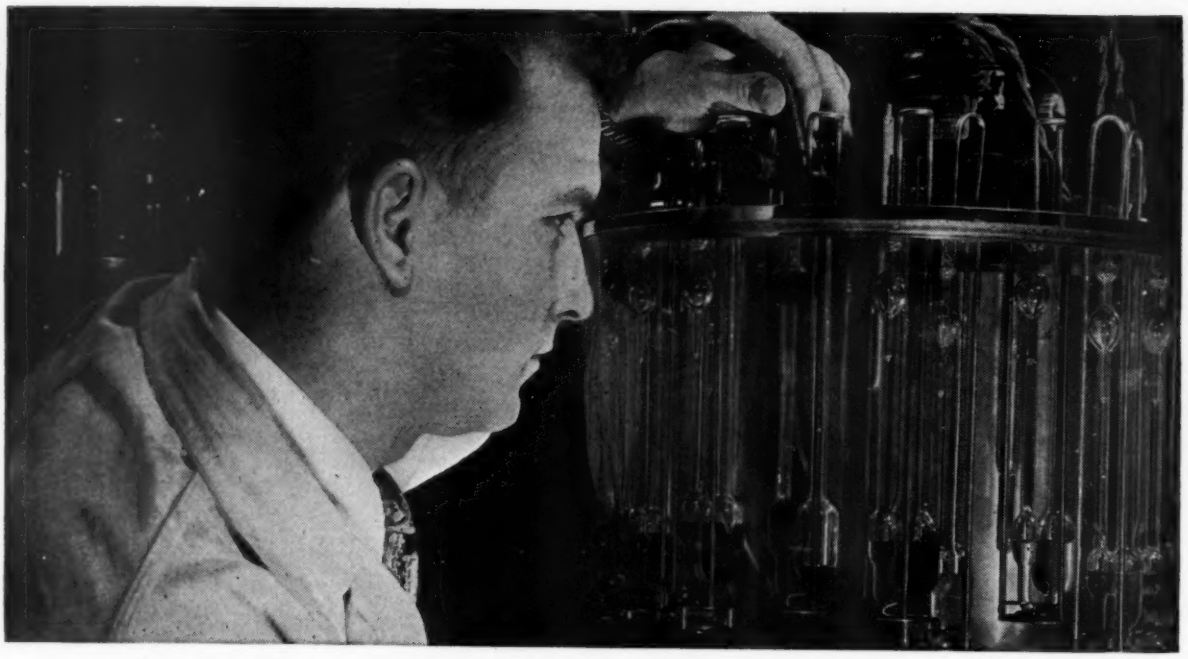

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tance since it limits solubility relations and governs the vapor pressures exerted. The general rule for wash temperatures is that they should be kept as low as possible. With waxes the low limit of wash temperatures is determined by the point at which solution of the wax, rather than its solidification, will occur. Fortunately, two conditions exist to aid solution; that the sorbed wax is in thin films and that a heat reservoir is provided by the adsorbent. For most waxes optimum temperatures for on-coming wash will range 135° to 150° F.

The first wash will contain 40 to 45% of wax whose color and filterability are of the same order as the raw feed. After stripping of naphtha, this material should be returned to charge. The stripped naphtha returns to clean wash naphtha for reuse. In the stripping operation it may be necessary to make a small slop side cut to prevent build-up of end point in the clean naphtha. The second wash will contain 10 to 12% wax. Depending on the color load and wash temperatures, this wash may or may not produce sufficiently washed adsorbent.

The first portion off, and perhaps the whole wash, will contain wax of approximately feed quality. The latter portion may contain some desorbed color bodies. If it does, the portion containing unfilterable wax should be segregated and reduced separately. The exact point of segregation is a study for each individual installation. A third wash, if used, will contain 3 to 5% of wax. This wash is sure to be unfilterable and should be separated from good wash. None of the unfilterable wash should ever be allowed to return to the filter system. Unfilterable wax is disposed of in plant fuel, cracking stocks, or such products as the refinery operators' ingenuity may suggest.

The total quantity of naphtha for each wash amounts to 4 to 5 bbl. of naphtha per ton with bauxite or 8 to 9 bbl. with fullers earth. The amount of naphtha-free wax which must be degraded to unfilterable stock is 0.2 to 0.4 bbl. per ton of adsorbent. Washing will require a time interval of one-half to one hour per ton.

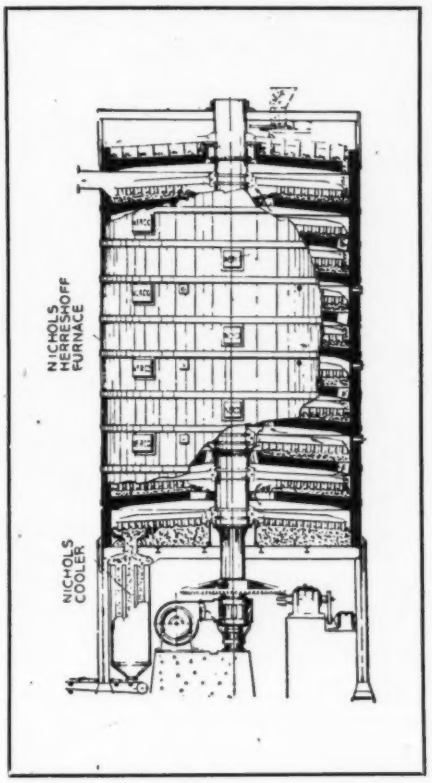

Fig. 5—Multiple hearth type regenerating kiln

8. Steaming.

The steaming operation is carried out to remove the remaining naphtha from the washed adsorbent bed and to dry it for ease in handling and control during regeneration. It consists of blowing live steam through the adsorbent bed until it is free from naphtha, as determined when naphtha odor can no longer be readily detected in the steam exhausting from the filter. The quality of the steam is of little importance as long as it is reasonably dry. Any saturated or slightly superheated exhaust steam will serve the pupose. Sufficient pressure is required to overcome the pressure drop through the bed. Steam consumption is 1500 to 2500 lbs./ton. Steaming time is from 15 to 45 minutes per ton.

During steaming, especially with bauxite, some further petroleum liquid will be desorbed. This product, termed "steamings," is usually a mixture of naphtha and desorbed impurities. The material is highly unfilterable and should go to unfilterable wash. In volume the "steamings" amount to 0.1 to 0.2 bbls./ton. The naphtha content of "steamings" is 50% or less. The final steamed adsorbent should have been reduced to 10 to 15% by weight of volatile combustible matter.

9. Dumping.

If the filter bed has been properly washed and steamed, the adsorbent should be as dry and free-flowing as when charged. With the type of bottom head recommended, no manual handling of the spent earth should be necessary beyond the control of the flow from the tail gate to the belt hopper. The speed of dumping is, therefore, usually limited only by the ability of the hopper and conveyor to carry the spent adsorbent away. With the average installation a filter may be dumped at the rate of 3 to 4 tons per hour.

10. Overall cycle time.

Overall cycle time is the sum of the time consumed in each operation. It will be noted that all the factors are approximately constant for any given filter with the exception of actual on stream time. On stream time varies with the yield and is numerically equal to the yield divided by the rate of take off. Overall cycle time may vary from a few hours to many days depending on the yield, side of filter, and take off rate.

Yields and Quality

In the percolation of waxes, two phases of the yield must be considered:

1. The volume of the specified prod-

TABLE 3—Typical Percolation Yields of Paraffin Waxes

Crude		Inspection before Filtering						Filter Temp.	Filtrate	
		A.P.I.	Vis. @ 210 °F.							Yield
Source	Processing	Gr.	S.U.	M.P. °F.	Color	%O+M	Adsorbent	°F.	Color	B.P.T.
Pennsylvania	Press-Sweat	45.2	36.7	124.3	+12 Say.	0.06	Bauxite	180	21 Say.	147.0
Wyoming	Unknown	43.4	37.2	124.5	+8 Say.	0.53	Bauxite	180	26 Say.	58.0
East Texas	Press-Sweat	38.7	39.6	134.0	¾ NPA	N.I.	Bauxite	210	30 Say.	31.8
Oklahoma	M.E.K.	37.6	37.3	122.3	1+ NPA	0.40	Bauxite	180	25 Say.	17.6
Oklahoma	M.E.K.	37.6	37.3	122.3	1+ NPA	0.40	Fullers earth	180	25 Say.	11.3
Oklahoma	Press-Acid Treat-Sweat	41.0	36.2	122.4	9 Say.	0.30	Bauxite	180	25 Say.	84.5
Illinois	M.E.K.	42.3	41.4	131.0	2¾ NPA	0.80	Bauxite	180	20 Say.	37.0
Illinois	M.E.K.	42.3	41.4	131.0	2¾ NPA	0.80	Fullers earth	180	20 Say.	32.9
California	Propane—M.E.K.	38.5	40.7	143.2	½ NPA	N.I.	Bauxite	200	30 Say.	250.5
California	Propane—M.E.K.	38.5	40.7	143.2	½ NPA	N.I.	Fullers earth	200	30 Say.	331.0

TABLE 4—Typical Percolation Yields Petrolatums and Microcrystalline Waxes

Crude Source	Processing	A.P.I. Gr.	Vis. @ 210° F. S.U.	MP °F.	Color	Adsorbent	Inspection before Filtering—Filter Temp. °F.	Filtrate—Color	Filtrate—Yield B.P.T.
Pennsylvania	Naphtha Centrifuge	31.0	93.6	132.3	5¾ dil. NPA	Bauxite	180	½ NPA	1.10
Pennsylvania	Naphtha Centrifuge	32.9	93.4	127.6	4+ NPA	Bauxite	180	½ NPA	1.78
Pennsylvania[1]	Naphtha Centrifuge	31.0	93.6	132.3	5¾ dil. NPA	Bauxite	180	½ NPA	2.09
Pennsylvania[1]	Naphtha Centrifuge	32.9	93.4	127.6	4+ NPA	Bauxite	180	½ NPA	2.42
East Texas	M. E. K.	31.8	74.5	166.5	7 NPA	Bauxite	210	1 NPA	21.6
California	Propane—M. E. K.	35.7	50.3	158.6	2¾ NPA	Bauxite	210	18 Say.	105.2
Illinois	M. E. K.	35.4	77.0	169.0	5½ NPA	Bauxite	210	1 NPA	17.0
Oklahoma	Unknown	31.9	77.6	185.0	Black	Bauxite	250	18 Say.	6.34
Oklahoma	Unknown	31.9	77.6	185.0	Black	Bauxite	250	1 NPA	11.4
Mid-Continent	M. E. K.	30.6	82.3	174.8	Brown	Bauxite	210	½ NPA	7.0
Mid-Continent	M. E. K.	30.6	82.3	174.8	Brown	Bauxite	210	1¾ NPA	15.9

(1) Using a recycle operation with 4½ NPA recycle stock.

uct which may be obtained from a given quantity of adsorbent.

2. The percentage of the feed stock obtained as the specified product.

In this discussion, the second category is termed ultimate yield. Yield when used without qualification refers to yield in bbls./ton.

Yields in general are influenced by crude sources and prior processing. For oils and waxes of similar composition yields in general decrease as color concentration increases. Specific examples of the yields obtainable from typical waxes are shown in Tables 3 and 4.

Ultimate yield is influenced by the yield per ton obtained and by the care in handling filter wash. Assuming that the wash is handled so that the least possible charge is degraded to unfilterable stock, it will be found that the hold-up of adsorbate and losses by degredation become approximately constant at about 0.8 bbl./ton. This figure varies little, regardless of the characteristics of the feed or whether or not a recycle operation is used. It can be seen, therefore, that the ultimate yield becomes larger as the yield in bbl./ton increases. With yields in excess of 50 bbl./ton recoveries of 98% or more of the feed as specification product may be obtained.

Concurrent with decolorization, filtrates decrease in density and viscosity. Melting point may increase or decrease. Decreases in melting point usually coincide with the removal of asphaltic types of color bodies. The more normal finding is a slight increase in melting point. Taste and odor removal with bauxite decreases to some extent when filtrates are run to darker colors. The complete removal of taste and odor seem to coincide with quantitative adsorption of aromatic and heterocyclic color bodies.

Equipment Requirements

The selection of the optimum size and quantity of percolation equipment requires a careful survey of the particular case involved. The use of larger filter shells tends to cut operating and installation expenses. On the other hand, large shells tend to increase operating inventories and sharply limit flexibility in changing products to market demands. Selection of shell capacity is, therefore, usually based on the best possible compromise between size and flexibility.

Burner capacities must be selected on the basis of the number of filters which must be handled per day. This is a direct function of the expected yield. Auxilary equipment is sized on the basis of the shell and kiln capacities selected.

The following fomulae are useful in estimating equipment requiremnts:

BBl. charged per filter;

$$C_f = (Y + 0.8) \times T$$

Filter turnovers per day;

$$F_t = C_d / C_f$$

Number of filters required;

$$F = (F_c/24) \times F_t$$

Daily Kiln charge in tons;

$$K_c = F_t \times T$$

Where:

C_d = Bbl. charged per day.
C_f = Bbl. charged per filter.
F = Number of filters required.
F_c = Filter cycle in hours.
F_t = Filter turnovers per day.
K_c = Daily kiln charge in tons.
T = Tons per filter.
Y = Yield in bbl. per ton.

If more than one stock is to be filtered simultaneously, calculations should be made for each stock separately. The total requirement of filters is the sum of that for the individual stocks. When the calculations result in a fractional number of filters, the next larger whole number is selected as the requirement. If a number of stocks are to be filtered consecutively, the greatest number of filters required for any of the stocks determines the number to be installed.

Choice of Adsorbents

For most waxes bauxite produces a better quality filtrate, in greater volume and at lower cost. This is not always true, however. Fullers earth may prove the more economical adsorbent for exceptional wax stocks, especially if the desired filtrate color lies in the range of 4 NPA or darker. With new stocks to be evaluated, the choice of adsorbents is best made by careful comparative percolation tests in the laboratory followed by economic analysis.

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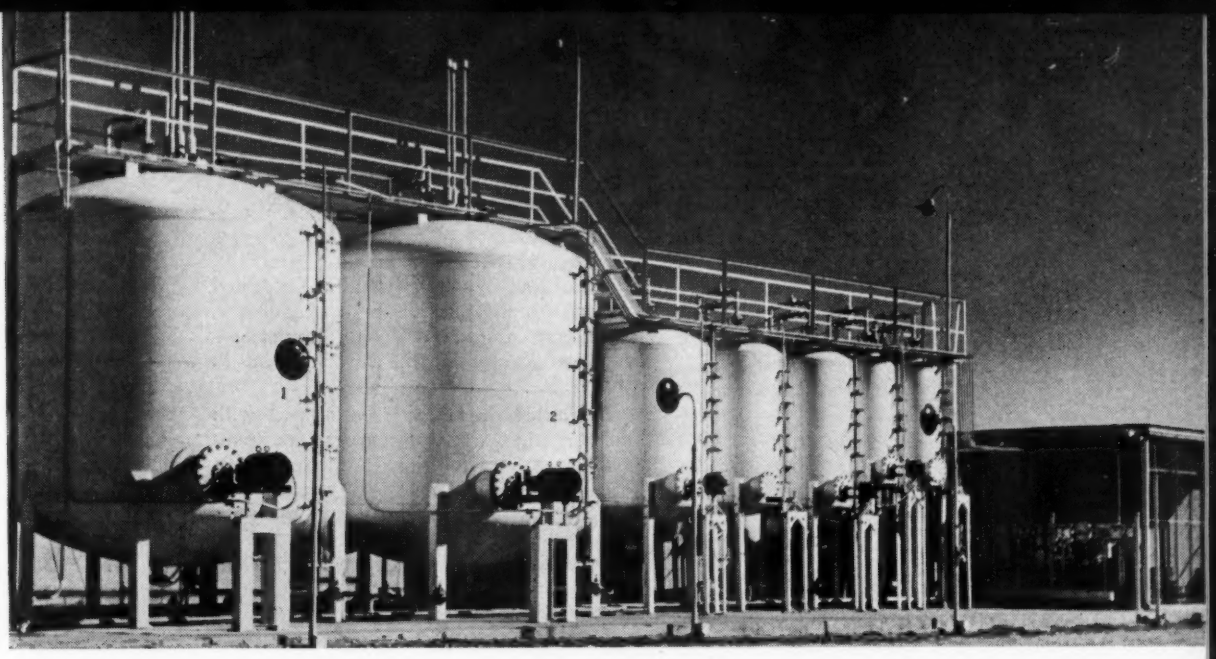

Fuel blending plant of Phillips Petroleum Co. at Phillips, Texas. Two 10,000 gal. tanks at left, smaller vessels at center. Ethanizing equipment in separate building at right

EXPERIMENTAL FUEL BLENDING

By H. C. WALTERS
Chemical Engineering Dept.
Phillips Petroleum Co.

A handicap to full-scale engine testing of fuels has been the lack of proper facilities for preparing the desired fuels in the volume needed. Meeting this need, Phillips Petroleum Co. at its research and development laboratories at Phillips, Texas, has built a blending plant where blends can be made in volumes ranging from a few gallons to tank car lots.

Seven pressure type tanks, from 300 to 10,000 gal. capacity, operate at 50 psi., making possible the blending of high vapor pressure products. Separate piping for raw stocks, finished products, and TEL treatment insures contaminant-free mixing.

Portable pumps and high pressure hose for tie-ins in transfer operations eliminate costly and complicated manifolds. Portable meters equipped with vapor eliminators and temperature compensators keep volume measurement errors below one per cent.

THE performance of an internal combustion engine is dependent upon a great many factors, most of which can be covered by such general headings as (a) engine design, (b) fuel and lubricant characteristics, (c) type of service, (d) climate, and (e) operating technique.

Each of these can be sub-divided at great length to give a multiplicity of problems faced by the engineers of two of the world's largest industries, engine manufacturing and petroleum refining. Although many of these problems may be the concern of only one of these groups, a large number are the responsibility of both.

The engine people and fuel manufacturers have a common objective—that of maintaining the best possible combination of engines and fuels. Experience has shown that problems of fitting fuels to engines and engines to fuels become more complicated with our constant improvements in engines and fuels.

During recent years much has been accomplished in the development of ways and means for determining what takes place within the induction system and cylinders of an internal combustion engine. However, much remains to be done in this field. We have not been able to develop simple laboratory test methods that will predict with certainty everything that may be expected from new types of fuel or changes in engine design. Any appreciable change in fuel characteristics or engine design usually alters the relationship of actual performance to the performance predicted by laboratory tests. Thus we are forced to revert to full-scale testing in order to secure fundamental information, prove the validity of existing test methods, and furnish data essential to the development of new methods of test.

Looking back through the past few years we see that increasing emphasis has been placed on full scale tesing. The number of full-scale engine test stands has increased considerably, especially in the aircraft engine and aviation fuel field.

Prior to the war considerable automotive engine road test work was being done, with a definite upward trend in octane number of fuels and in compression ratio of engines. This road testing was found necessary to maintain the proper relationship between fuels and engines. The war caused an abrupt halt in these activities, with the emphasis being shifted almost entirely to airplane engines, military ground vehicles, and aviation fuels. Flight testing of fuels, which was being carried out on a comparatively small scale up to this time, suddenly came into its own. With the return to peace time conditions, automotive problems are being picked up where they were dropped in 1941.

It must be admitted that full scale tests are costly and time consuming when compared with laboratory tests. However, it is the belief of the writer that the costs and time involved are not excessive considering the value of the information that may be developed if tests fuels are properly selected for the specific problems at hand. Selection of test fuel specifications is of prime importance, and poor judgement in this connection can reduce greatly the value of subsequent test data. This is especially true where difficulties of the borderline variety are being studied.

In the past one of the major handicaps to full scale testing has been the lack of facilities for preparing extreme type fuels in the volume required. Blending facilities available at the average re-

finery or gasoline plant are not adaptable to the blending of experimental fuels, which must be made in relatively small volumes and with extreme accuracy.

Another factor that has limited the possibilities of full-scale testing until recently has been lack of sufficient volumes of individual hydrocarbons and of hydrocarbon mixtures of known composition. Many of the recent improvements in fuel quality may be attributed to information obtained through blending and testing individual hydrocarbons, including normal butane, isopentane, neohexane, triptane, isooctane, diisopropyl, etc.

Our present day refinery processes are designed to separate pure hydrocarbons, or classes of hydrocarbons, from crude petroleum and to change the chemical structure of hydrocarbons. The ultimate goal is to obtain blending stocks which may be combined to give the most desirable mixture from the standpoint of the performance it imparts to the engine.

In order to meet the need for facilities that can be used to prepare extreme types of fuels for full-scale test work, Phillips Petroleum Co. has built a special blending plan which is operated in conjunction with the Company's new research and development facilities at Phillips, Texas. The plant is located in close proximity to full-scale refining operations as well as to pure hydrocarbon manufacturing facilities which serve as the sources of most of the blending components for the plant. The plant was designed for making blends ranging in volume from a few gallons to tank car lots. During its first year of operation approximately 200,000 gallons of experimental fuels, largely aviation, were blended.

Blending Tanks

Seven pressure type tanks varying in size from 300 to 10,000 gal. are used for the actual blending operations. Working pressures of 50 psi. make it possible to blend high vapor pressure products. All tanks are cylindrical and are installed in an upright position in a single row. To insure complete drainage, bottom outlets are located at the lowest point in the tank.

Each blending tank is equipped with side-entering direct drive mixers, consisting of explosion-proof motor, shaft, and three-blade modified marine-type propellers. Mixer motors are mounted on steel platforms supported from the floor. Liquid covers the propellers when the tanks are approximately one-fifth full. Mixers are allowed to operate for at least 30 minutes; however, complete mixing is usually accomplished in about 15 minutes. When preparing blends of from 10,000 to 20,000 gal., two 10,000 gal. tanks are manifolded together in order that the blend may be circulated through both until mixed. When this practice is followed, a mixing time of several hours is used.

Ethylizing Equipment

Since nearly all aviation gasoline and motor fuel contains tetraethyl lead, facilities for handling this material must be included in any complete blending plant. As far as known, this is the only small plant of this type in operation at the present time.

Because of the relatively small volumes involved, the design of an accurate and safe means of adding ethyl fluid presented somewhat of a problem. From a safety standpoint, it was necessary to construct a building to be used only for ethylizing operations. This building is located at one end of the row of blending tanks. Ethylizing is accomplished by pumping the gasoline from the bottom of any one of the blending tanks through an eductor, located in the ethyl building, and back into the top of the tank.

Drums containing 20,000 cc. of ethyl fluid are used in the ethylizing operations. The fluid is measured into the gasoline by weight. Platform scales with the beam graduated in hundredth-pound divisions are used for this purpose. The scales are installed in a floor pit which is connected to a chemical sewer.

When a drum of fluid is placed on the scale platfom, it is connected with the eductor by the use of a special standpipe, swing joints, and the necessary piping. The standpipe is screwed into the opening in the drum to give an air tight connection. The flow of ethyl fluid into the gasoline stream is regulated by a hand operated valve on the standpipe.

The valve opening necessary to give the desired rate of flow is indicated by the vacuum in the line between the eductor and drum. This vacuum is measured by means of a gauge calibrated to read in inches of mercury. As fluid is removed from the drum, air is admitted by means of a sidearm and valve on the standpipe. When the desired quantity of fluid has been added, a wash line is connected to the sidearm and gasoline is circulated through the drum and/or standpipe to remove residual ethyl fluid.

Piping & Transfer Pumps

To avoid contamination, separate piping is used for raw stocks, for finished gasoline, and for gasoline containing tetraethyl lead. These lines slope to an underground waste tank and may be drained completely when necessary. Except for piping carrying the ethyl fluid-gasoline mixture from the ethyl building to the blending tanks, all line-to-tank connections are made by means of high pressure hose, which is removed and drained after each transfer.

In order to eliminate complicated and

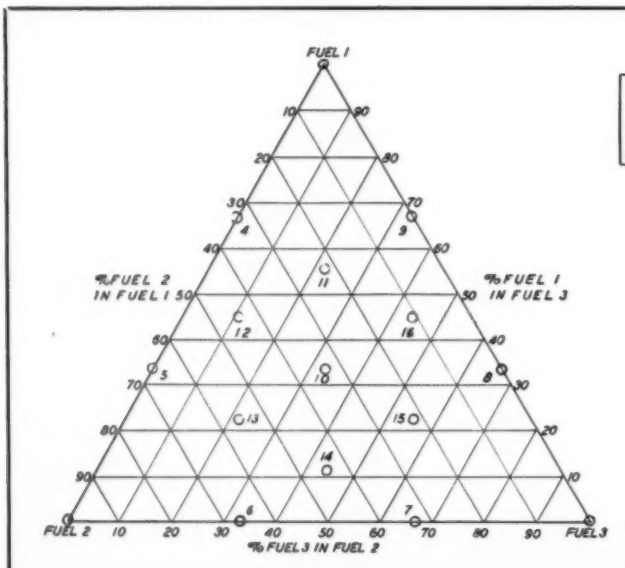

Fig. 1—Fuel blend composition chart using three base fuels to make 13 different blends

EAD TEMPERATURE °F			
	DEWPOINT	60 %	20 %
FUEL 1	79	36	-51
FUEL 2	16	-25	-68
FUEL 3	61	27	-19

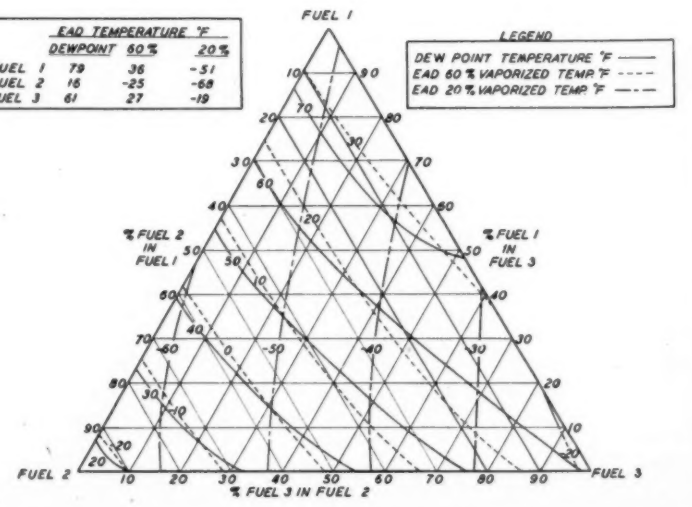
FUEL 1
LEGEND
DEW POINT TEMPERATURE °F
EAD 60 % VAPORIZED TEMP °F
EAD 20 % VAPORIZED TEMP °F
% FUEL 2 IN FUEL 1
% FUEL 1 IN FUEL 3
% FUEL 3 IN FUEL 2
FUEL 2
FUEL 3

Fig. 2—Equilibrium air distillation characteristics from the blends shown in Fig. 1

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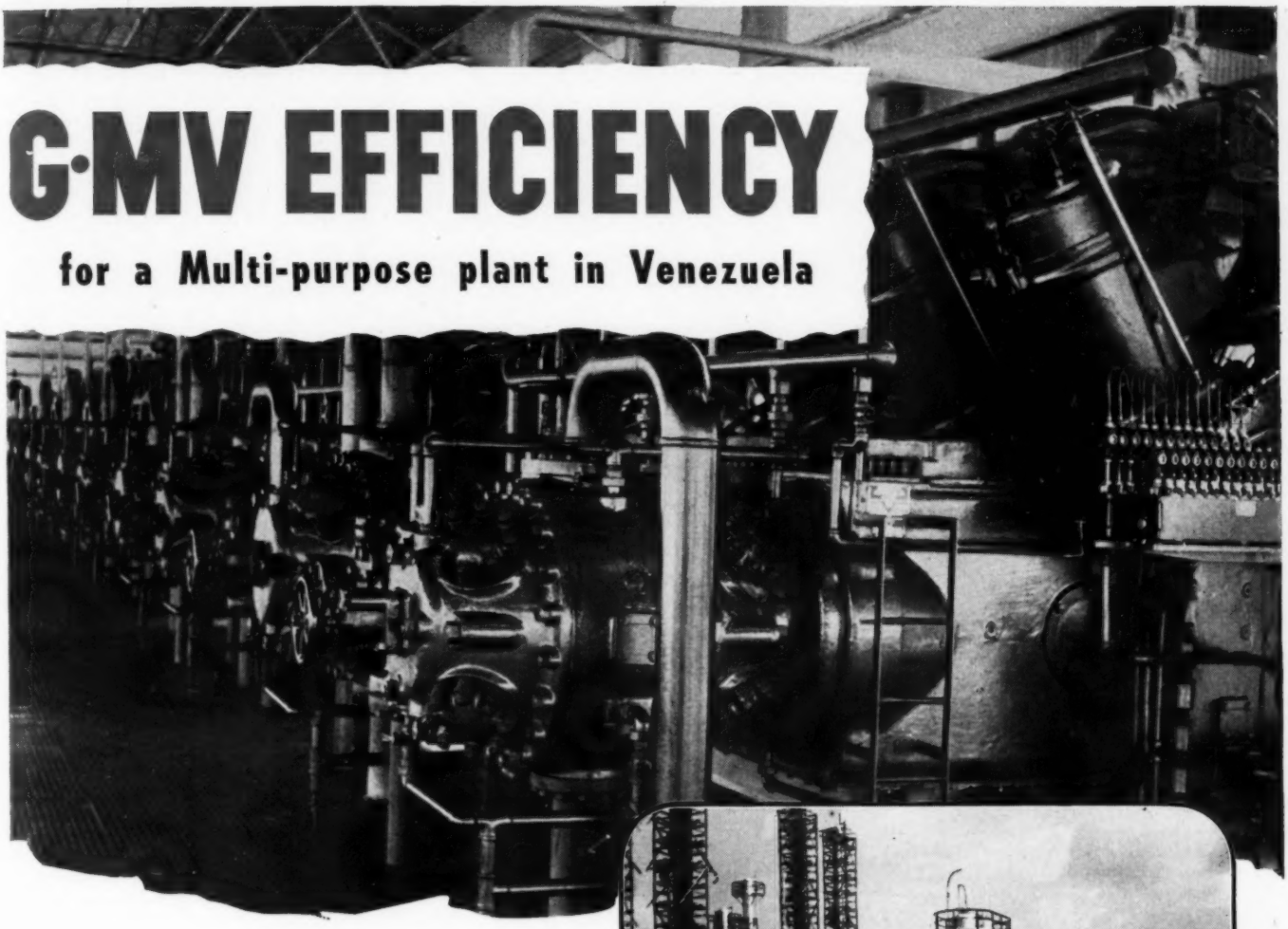

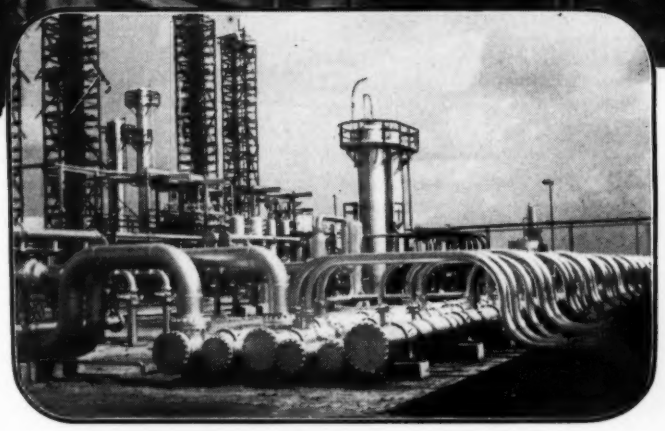

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INSERT: General view of compressor manifold piping, gas dehydrating unit and towers at plant of Compania Consolidada de Petrolea, Venezuelan subsidiary of Sinclair Consolidated Oil Company.

ABOVE: Battery of seven modern Cooper-Bessemer V-angle units, one vacuum and six 3-stage compressors, each a 6-cylinder, 600 hp GMV.

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TABLE 1—Characteristics of Certain Blending Stocks

Blending Stock	RVP	Engler Dist.—°F. IBP	50%	EP	ASTM Octane Number Clear	3 ml. TEL
Isopentane	20.0	79	82	89	88.2	0.58(1)
Isohexane	7.4	132	138	142	79.4	96.6
Isoheptanes	3.2	175	178	190	74.0	89.0
Mixed pentanes	16.6	89	93	102(2)	79.5	90.2
Normal hexane	4.9	153	156	156	47.1	74.0
Iso-naphtha	0.1	356	368	396	...	94.7(3)
Normal naphtha	0.1	357	372	422	...	51.8(3)
Iso-naphtha	0.6	287	297	315	...	93.2(3)

(1) cc's TEL in primary iso-octane—(2) Dry point—(3) 4.0 ml. TEL.

costly piping manifolds, portable pumps are used in transfer operations. Here again high pressure hose is employed in making tie-ins.

In operations where a relatively low discharge line can be maintained and where it is necessary to close the discharge line repeatedly, as in drum loading, a small centrifugal-type pump is used. Where high discharge pressures are encountered, and for general all-purpose work, a turbine type pump is employed. Both pumps are self-priming, thus enabling them to work on a suction lift.

Meters

As a rule experimental fuels must be made to meet very rigid specifications. The degree to which this can be accomplished is, of course, largely dependent upon the accuracy with which the volumes of individual components are measured. Gauge glass readings do not give the desired accuracy of measurement, especially when handling small volumes and when temperature differences are encountered. To overcome this difficulty portable meters equipped with vapor eliminators and temperature compensators are used. They have proved very reliable.

In the preparation of experimental fuels, it is extremely important that all specifications be met with the best possible accuracy. Before the actual plant blending of a finished fuel is begun, it is generally necessary to make small laboratory trial blends. After a laboratory blend meeting all specifications has been prepared, the problem then is simply one of reproducing the small blend in the plant.

The success with which this may be accomplished is dependent upon (1) accuracy of volume measurements, (2) degree of contamination, and (3) extent of weathering. Experience has shown that errors in volume measurement can easily be held below one per cent by using the type meter described above. Contamination is completely eliminated by draining lines before product transfers are made. The use of pressure tanks reduces weathering to a minimum.

Blending to Specifications

For the most part the fuel blender is concerned with four variables. These are vapor pressure, distillation, anti-knock value and TEL content. Of course, all finished blends must meet specifications for gum, corrosion, sulfur, etc., but these are primarily the concern of the refiner who prepares the individual blending stocks.

As pointed out before, it is necessary before proceeding with full-scale blending opeations that a laboratory blend meeting all specifications be prepared. The amount of blending and testing necessary to arrive at this blend is largely dependent upon (1) the number of individual ingredients involved and (2) the number of specification points to be met. Obviously more trial blends and tests would be required for a fuel having both 50 and 90% distillation temperatures specified than if only one of these is to be controlled.

As an example, let us consider the simple case of a blend having 7 lbs. Reid vapor pressure, a 50% distillation temperature of 175° F., and an ASTM aviation octane number of 100. Assume that stocks available for blending are isopentane, alkylate, a light base stock, and a heavy base stock.

The first step is to add sufficient isopentane to each of the other three stocks to give three blends having a Reid vapor pressure of 7 lbs. In step two isopentanized alkylate is added to the isopentanized light base stock to give a blend having a 50% distillation temperature of 175° F. and an octane number greater than 100, and the isopentanized heavy base stock is blended with the isopentanized light base stock to give a blend having a 50% distillation temperature of 175° F. and an octane number less than 100.

Step three consists of cross-blending these two fuels to give a blend meeting all three specifications. If a 90% distillation temperature is specified also, it is easy to visualize that probably at least one additional blending stock and a greater number of trial blends would be required.

It is not intended to imply by the above example that a step by step procedure of trial blending must be carried out for every fuel blended. Such a procedure is necessary only when extreme types of fuel and/or blending stocks are involved. In preparing conventional types of fuel using typical blending stocks, knowledge gained through past experience can be used to reduce the number of trial blends required.

The number of individual components which the blender is required to use in making a given blend is dependent upon (1) the type of fuel (paraffin, naphthene, aromatic, or olefin) to be blended and (2) the inspection and antiknock specifications to be met.

The ideal situation would be to have available quantities of all hydrocarbons boiling within the gasoline range. This is, of course, impossible even in small scale operations. The next best condition, and the one which is followed in making extreme types of fuel, is to use narrow boiling fractions of hydrocarbon mixtures together with those essentially pure hydrocarbons which are available.

The flexibility which can utilized in blending to widely variant and rigid specifications is governed by the number and characteristics of the blending stocks available. In order to blend to volatility specifications alone, only one fraction is needed for each of the boiling ranges into which the distillation curve may be divided. When blending conventional fuels, the boiling range of these fractions may be rather broad; however, when preparing fuels of extreme volatility characteristics, it is often necessary to use very narrow boiling fractions or pure compounds. In order to have maximum flexibility in varying fuel type and and octane number, it is deirable to have a certain number of blending stocks having the same boiling range but of a different type and/or octane number.

In operations of the experimental blending plant described herein ten components have been the maximum number used in any one blend thus far. In all blends made to date a total of over 35 different blending stocks have been used. A few of these, together with their characteristics, are shown in Table 1.

When preparing fuels for an extensive test program, it is often necessary to make a series of blends and establish a pattern from which changes in performance characteristics with changing fuel composition or characteristics can be followed.

Such a series of blends is outlined in Fig. 1, where a total of sixteen fuels are used to establish the pattern. The three fuels representing the corners of the chart are base fuels and the other thirteen are different blends of these. Fig. 2 is included to show how data from such a series of blends may be used to give a comprehensive picture of changes in characteristics with changing composition.

Equilibrium air distillation (E.A.D.) data are used in the example and, although it is not the purpose of this article to discuss the relative merits of test methods, it is believed that the possibilities of this test should always be considered where problems in volatility are involved. If sufficient correlation of E.A.D., A.S.T.M. distillation, and full scale test results can be established, many short cut solutions to the problems of volatility will result.

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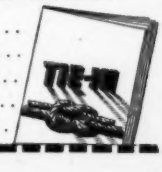

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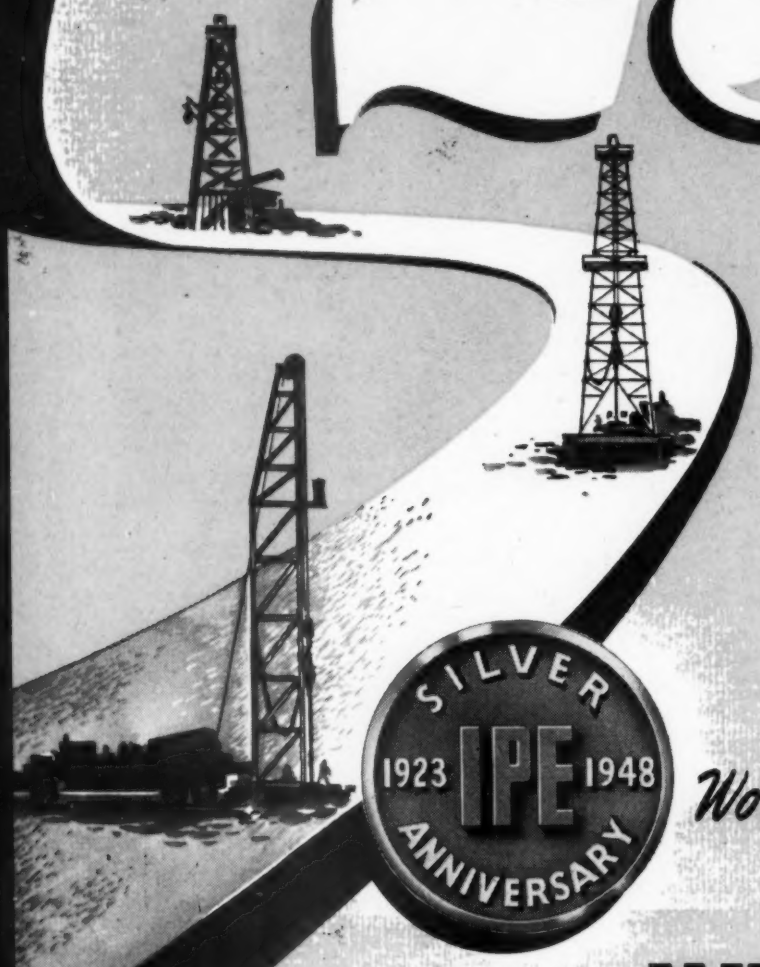

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Methods for Handling Emulsions in Wastes

(Concluding Article in the Series)

By W. B. Hart
In Charge of Waste Disposal, Atlantic Refining Co.

Emulsions encountered in refinery wastes are of two types: stable (oil dispersed in water) and unstable (water dispersed in oil). The stable emulsions are more difficult to handle usually and require treatment with chemicals to break them. The method of treatment may be strictly chemical (either batch or continuous process) or flocculation, which also employs chemicals but in certain aspects is physical in nature.

The unstable or water-in-oil type of emulsion can sometimes be broken by the application of heat alone, although they may require chemical treatment as well.

When particular circumstances require a greater removal of oil from waste water than can be achieved by an oil-water separator alone, three treatment procedures are available—simple filtration, bio-filtration and flocculation. The former is usually the least expensive, although flocculation does a better job in most cases and also cleans up emulsions.

This article, No. 20, is the concluding one in the series on modern methods for the treatment of refinery wastes, which has been appearing exclusively in *PETROLEUM PROCESSING* since January, 1946. Reprints of the entire series are available in book form, and details on how to secure them are explained in the box at the end of this article.

EMULSIONS do not seem to be well known or understood by most refinery personnel. To many the term emulsion means only that type of intimate mixture of oil and water which is encountered in tank bottoms, in oils recovered from separators, and so forth. In such emulsions the oil is in the continuous phase, and the water is in the dispersed phase. These emulsions usually occur in masses, or "globs", and in nearly ever instance they will float on water. They are bound, quite often, by a septum-like film, but usually are readily broken down so that the oil and water can be separated. Because they present a lesser problem their discussion will be deferred.

In stable emulsions the water usually is in the continuous, and the oil in the dispersed phase. The oil is dispersed in minute globules of practically uniform size, and bound either by electrical charge (Hydrosols) or by enveloping films of compounds which are emulsifying agents. In either case the globules are prevented from merging, one with another, and therefore the oil will not separate from the water. Such emulsions usually are milk white or cream white in color, of greater viscosity than water, and if mixed with distilled water will transmit their characteristics so that the entire mixture is involved. This involvement varies with the degree of dilution, until in the case of great dilution only an opalescence results.

But when diluted with natural waters to a degree which permits neutralization of the electrical charge, or precipitation of the chemical emulsifying agent, the oil is freed and can agglomerate. It then separates from the water and rises to the surface. If the dilution takes place in a stream or lake, oil pollution in some degree follows. No practicable degree of sedimentation, however, will bring about a separation of the oil. Some form of chemical treatment is necessary.

There are various procedures by which emulsions of this type can be broken, and the oil released. They may be classified as "batch chemical", "continuous chemical", and "flocculation" methods. Although a method sometimes may seem to be desirable because of its suitability for the quantity of emulsion to be treated in a given period of time, no method should be selected on the basis of the mechanics alone. The selection should be based primarily upon assurance of success of the procedure, obtained by a careful and thorough laboratory and pilot plant investigation. Such a study will show the most effective and economical reagent for breaking the emulsion. When this has been proved, attention may be turned to its most efficient application.

There should not be any great need for discussion of a laboratory investigation here. It might be suggested that the start of the investigation may be made by trying heat alone. This is not often successful, but on occasion it has been. The extent to which heat is applied in the laboratory should be commensurate with the degree which will be practicable on the plant. The success of the investigation of the effect of heat should be noted for comparison with later findings.

The next step in the investigation concerns itself with the effect of various chemicals. For this it has been found convenient in the past to use a low power microscope and a long glass slide in which there are several cup-like depressions. The slide is illustrated in Fig. 1. It can be purchased on specification.

A quantity of the emulsion is placed in each depression, and a drop or two of the treating chemical is added from an eye-dropper. Each depression is used for a different chemical to be tried. The slide then is moved across the stage of the microscope in such a manner as to permit examination of each test, and the results (i.e., the success attained in breaking up the emulsion) are noted. Usually, several of the chemicals will cause a "break". These successful treating agents then should be investigated on a quantitative basis, using a large quantity of emulsion so that the economics of the treatment can be analyzed. Finally, the various reagents can be reduced in number so that not more than one or two need be applied in pilot plant operation. Obviously, variations of the procedure may be worked out.

Reagents for breaking emulsions of the type in question should be salts of metals heavier than sodium. They also should contain a metallic ion which will produce an insoluble compound with the sulfonic, naphthenic, or other complex organic acid, the sodium salt of which usually is responsible, at least in part, for the emulsion stability. Soluble salts of calcium, magnesium, iron, and aluminum have been used to break sta-

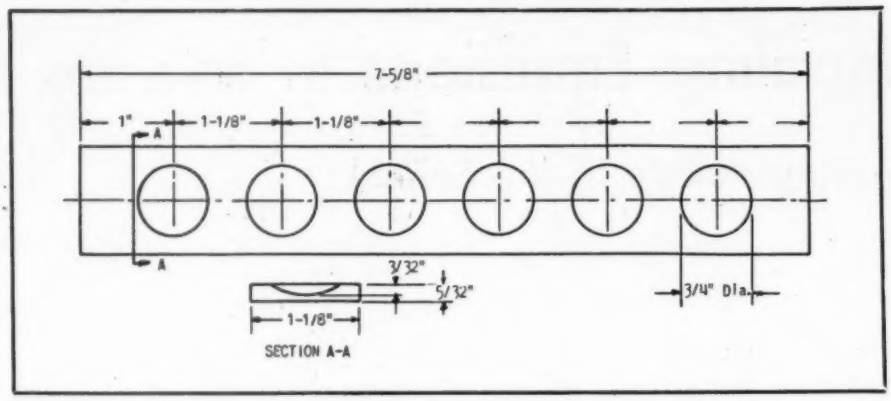

Fig. 1—Microscope slide for the study of emulsions

ble emulsions from refineries. Other chemicals may be satisfactory, either as a principal treatment, or as an aid in the use of one of the chemicals mentioned above.

Batch Chemical Treatment

Batch treatment of stable emulsions is practicable where relatively small quantities are produced each day. The only facilities necessary are tanks properly equipped. There should be at least two tanks, each capable of holding the quantity of emulsion produced each day plus additional room for the treating agent. The tanks should be equipped with the necessary inlet and suction lines and a draw-off line to the plant sewer system. There should be a swing suction line with a skimming device which can be adjusted to a level position at any elevation above the half-full level. Agitation can be provided by compressed air distributed from a perforated pipe-cross near the tank bottom. The tanks need not have roofs, but should have ample bottom manholes so that they can be cleaned readily.

The treatment chemical may be added in either solid form or in solution, depending upon the nature of the chemical and upon convenience. If the chemical is to be added in solid form a scale will be necessary for weighing the proper quantity. Also, some form of device will be required to raise the containers of chemical to a dumping platform at the top of the tank. The simplest form of device for this purpose is a so-called "block and fall" hook-up suspended from above the dumping platform, and to one side, so that the containers can be raised to the platform level and pulled in on it.

If the chemical is to be added in solution, a solution tank will be necessary, with facilities for ready dumping of material as received. Storage space, properly protected, also should be arranged so that a stock may be maintained. Some means for determining when the solution is of the right strength must be provided and also a means for measurement. A measuring pump will serve this purpose well, and also will transfer the solution to the tanks. The general arrangement of a plant for batch emulsion treatment is shown in Fig. 2.

The treatment operation is relatively simple. The emulsion is collected from its source, making sure that none escapes to the sewer system. It is delivered to one of the treating tanks until the tank is filled to a predetermined level. The operation should be so arranged that this will represent the emulsion production of one day.

With the air agitation started the solid or solution treating agent then can be added in predetermined quantity. This quantity may be established for any unusual charge by laboratory study of the batch to obtain a break. Day to day operation soon will establish an "experience" quantity of treatment chemical to be necessary, and a slight excess may be added to take care of any "peak" conditions of stabilization.

Relatively gentle agitation should be continued for at least one hour, after which the air is shut off and the tank contents are allowed to settle for several hours, or until a good separation is obtained. The released "oil" (usually a soap) rises and forms a layer on the surface. It can be skimmed off readily and delivered to some point as fuel, for it will contain organic materials which probably will not be acceptable as charge stock for rerunning.

The water layer should be sampled before it is discharged to the sewer. The sample should be examined to make sure that all milk-like appearance or opalescence has been eliminated, indicating that the emulsion has been broken completely. The water in the sample should be almost completely clear (i.e., have a turbidity of less than 35 to 50 ppm as determined by the Jackson turbidmeter or equivalent). A study of the pH during all steps of the treating operation will serve as a good guide for treatment control. By determinating the turbidity a few times, sufficiently accurate estimation of the fitness for disharge of the settled water can be based on judgment.

Continuous Chemical Treatment

Continuous chemical treatment differs little, fundamentally, from the batch operation. But by effective arrangement of the various items of equipment the operation can be made much more flexible and more economical than the batch method.

The arrangement of the equipment for the continuous process is shown diagrammatically in Fig. 3. This arrangement permits both chemical and thermal treatment of emulsion or a combination of these methods, and if sufficient

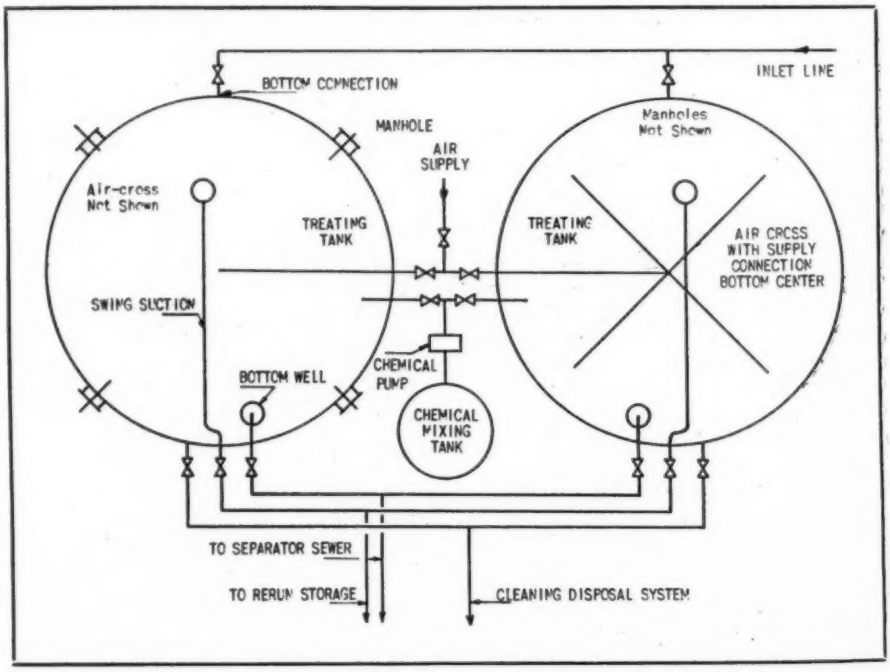

Fig. 2—Diagrammatic flow system for a batch chemical treating plant for handling stable emulsions

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treating capacity is provided, water-in-oil emulsion (e.g., emulsion collected from separators) can be handled in the same unit. The equipment diagrammed in Fig. 3, of course, may be modified as necessary for local needs.

The operation of the continuous plant is relatively simple. Having established in the laboratory the treating agent which will give the most effective and economical break, and also whether heat is or is not beneficial, the treating solution is prepared for the feeding device and the flow through the system is started. Test samples are collected from time to time from the discharge line leading to the settling tanks and settled so that there can be assurance that a good break is being obtained. Careful attention to this feature is essential to good operation. The water below the oil should be practically clear, and free of any opalescence. Also, tests can be made to determine whether excessive amounts of treating agent are being used.

The treated charge is collected in the settler and held for a period to permit the oil and water to separate. When this has taken place, the water is drawn off to the sewer, and the oil is delivered to storage for burning. Variations of procedure may be developed in different refineries, since conditions may differ widely. For this reason only a general process description can be presented. The feeding equipment used is quite specialized, and may be unfamiliar in a refinery, therefore, the vendors should be consulted concerning type and capacity for the purpose.

Flocculation

Flocculation provides what probably is the ultimate in procedure for breaking most types of stable emulsions. It also will bring about the ultimate in high degree of oil removal from separator effluents where, for some unusual reason, a high degree of clean-up is necessary.

Flocculation definitely is a chemical process, but in certain aspects it is physical as well. Basically, the process consists of adding chemicals to the solution to be treated (e.g., the waste), to produce a somewhat dense, gelatinous precipitate. To this extent the process truly is chemical. The next step is to so agitate the solution that the gelatinous nature of the precipitate is changed to a particulate one. During the course of this change even the finest particles of suspended matter become enmeshed in the precipitated substance, and when the latter is removed from suspension by sedimentation, an almost brilliant, crystal-clear waste water results.

The chemical treatment to provide flocculation has two effects when applied to the type of stable emulsion here under discussion. It not only releases minute globules of oil which have been bound electrically, but it also precipitates the stabilizing substance which binds other globules. Then both the oil globules and the precipitated binding matter are enmeshed and retained in the floc formed by subsequent gentle agitation.

The final floc formed has a certain capacity for picking up and retaining oil particles. Therefore, before flocculation is applied, any considerable amount of free oil must be separated and removed from the waste flow. This also is the most economical procedure, for when it is followed, it is not necessary to remove the oil from the separated floc sludge before it can be reconditioned.

A plant for treating stable emulsions may vary in design depending upon the rate at which the emulsion is produced, and also upon whether it is produced continuously or intermittently. When the emulsion is produced continuously, as for example by a barometric condenser on a vaccum still, the emulsion breaking plant also should be designed for continuous operation. Such a plant will consist of a preliminary separator, the chemical treatment or "flash" flocculation tanks, the final clarifier, and equipment for treating the sludge for oil recovery or disposal, as the economics of the oil content may indicate. A diagram-

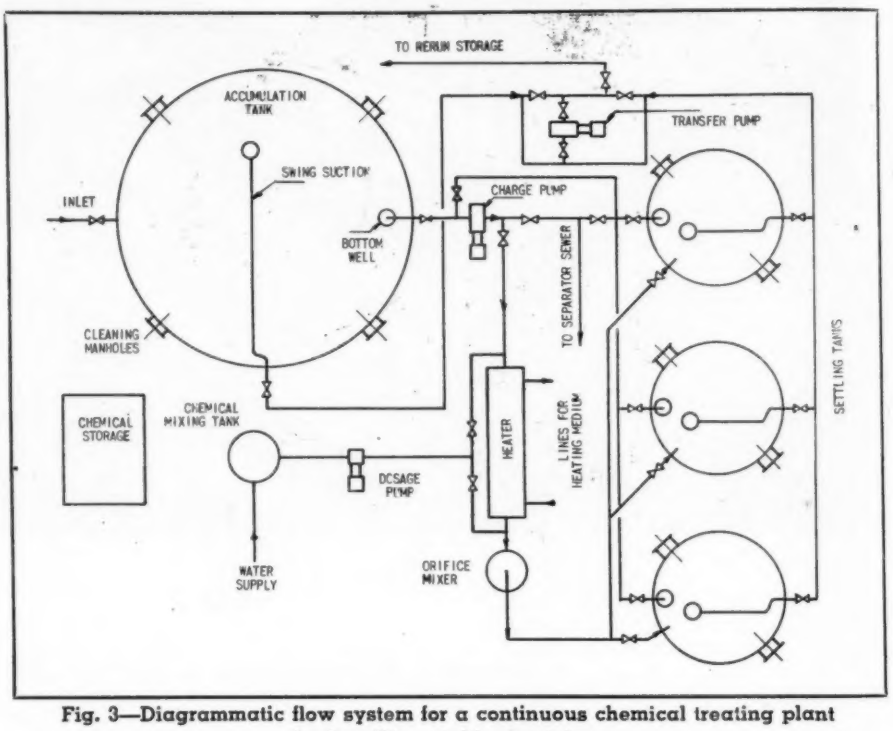


Fig. 3—Diagrammatic flow system for a continuous chemical treating plant for handling stable emulsions

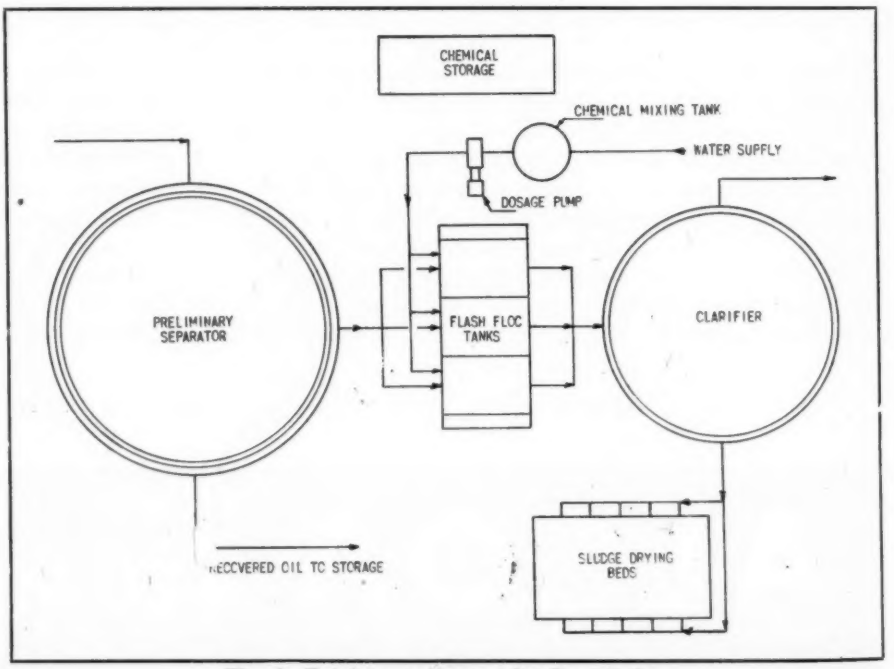


Fig. 4—Emulsion treatment by flocculation

matic arrangement of such a plant is shown in Fig. 4.

A plant to function on intermittent production of emulsion, such as a lubricating oil treating plant, will require a tank in which the emulsion can be accumulated as produced. This tank should have ample capacity for retaining the production of perhaps two days. The tank also will serve as preliminary separator and should be equipped for skimming the free oil which separates and accumulates on the surface.

From the bottom of the storage tank, or tanks, a line can be taken directly to the "flash" floc tanks of a flocculation unit which should be of a size which will permit treatment, by continuous operation for 24 hours, of all the emulsion produced in 24 hours. Such a plant obviously can be operated at a rate which will be much lower than would be the rate at which the emulsion normally comes from the producing units. The treatment plant otherwise is the same as that for treatment of emulsion continuously produced.

Emulsion treating plants of the type here being discussed make use of patented devices which vary somewhat in detail as designed and constructed by various vendors of sewage and water treating equipment. It will be most advisable, therefore, to discuss the problem with several vendors and learn the details and desirable features of their respective equipment. If possible to arrange it, pilot plant demonstration should be conducted so that all features of the operation can be carefully observed. Then, the most desirable equipment for the particular application can be selected and installed with confidence.

Various treating chemicals are used in flocculation plants but usually one or perhaps two will show themselves to be best for the particular refinery. The chemical nature of the refinery water supply plays an important role in the effective action of any chemical as a treating agent. The hydrogen ion concentration in the emulsion to be treated also is of great importance, as is the presence, or absence, of soluble sulfides, such as hydrogen or sodium sulfide. The hydrogen ion concentration affects the floc formation while the sulfides will precipitate any heavy metal ions such as iron and lead and produce a dark or perhaps deep black effluent. The usual treating chemicals are various soluble aluminum and iron salts, e.g., alum, ferrous sulfate with chlorine, and ferric chloride, with or without lime.

Alum salts, even at the optimum hydrogen ion concentration (pH) of 6.5 to 8.0 may produce a floc which will be too light to settle readily. This can be overcome by feeding finely divided clay together with the alum. The clay will load the floc particles so that the gravity of the aggregate will cause it to settle rapidly and the clarifier will deliver a practically clear and oil-free effluent.

Iron salts, for most satisfactory flocculation, require a pH of 8.0 to 9.5. Adjustment to this value with lime may be necessary. Iron salts will react with soluble sulfides to form colloidal iron sulfide and cause an unsatisfactory, black effluent from the clarifier. This has been avoided in practice by feeding lime together with the iron salt. A very satisfactory effluent results.

The quantity of chemical feed will vary with the mineral characteristics of the water supply and the type of emulsion. It may range from 20 to 80 or more parts per million (by weight). Correspondingly, the cost may vary from $5.00 to perhaps $15.00 per million gallons of emulsion.

The successful practice of flocculation for breaking emulsions or cleaning up separator effluents depends largely upon producing a hard floc which will settle rapidly. This, in turn will depend upon providing proper conditions of pH, treatment chemical, form and rate of agitation, and other factors. For this reason, there is no process in which laboratory and pilot plant investigation is more important. No process or equipment for plant application should be designed without such investigation. There is practically no literature on flocculation for breaking emulsions, but there is an extensive literature on flocculation as used in sewage treatment. Keefer[1,4] presents a rather complete discussion.

There is another procedure which may develop into a very successful process for breaking emulsioins of both stable and unstable types. The procedure referred to is that using supersonics. Practically no direct experimentation has been conducted in this connection, but work is being planned.

Treating Water-in-Oil Emulsions

Emulsions of the water-in-oil type occur at many points in a refinery. They develop as tank bottoms in crude oil storage tanks, and when these tanks are cleaned, the emulsions must be treated for disposal. Similar emulsions develop as bottoms in tanks for the storage of intermediate products, and in so-called running tanks, i.e., the tanks in which various distillates are collected. They will develop to some extent at almost any point where oil and water are in contact.

Emulsions of the water-in-oil type usually contain a rather high percentage of oil and not a great deal of water. The oil usually is rather heavy, i.e., its specific gravity approaches that of water. The light oils do not form such emulsions very frequently, but sometimes when conditions are just right even kerosine will emulsify to produce a water-in-oil emulsion.

The type of emulsion here under discussion usually will float on the surface of the waste water. It may occur as yellowish, to very dark brown "liver-like" masses, which will cover uniformly the entire bottom of a tank, or it may appear as almost black "globs," surrounded by free oil, on the surface of a separator. Sometimes, globs will appear in an almost clear stream of waste water. They are quite amoeba-like in their constant change of shape, but are many times larger than any amoeba. Such masses often are of almost the same gravity as the waste water in which they are carried, without, seemingly, any inclination to rise or sink. The film rupture chamber of the modern separator is very important in the treatment of this particular form of the water-in-oil emulsion.

If emulsions of the water-in-oil type are examined, their cellular-like structure, which has been mentioned earlier in these articles, can be observed. The "cells" will vary in size from quite large, as in emulsions carrying the lighter oils, to quite small, as in the liver-like varieties. It will be noticed also that the cells are surrounded by a membraneous structure which retains the water, and that the whole glob also is surrounded by such a structure. This membrane must be destroyed in order to release the water and permit the oil to agglomerate and rise.

Sometimes these membranes are comparatively strong. In large degree, this is due to the stabilizing effect of very finely divided particles of coke, cinder, clay, and so forth, which tend to augment the normal surface tension effects. But if an emulsion of this kind is rubbed between the fingers, it ruptures readily and the water escapes. The oil agglomerates. Also, if the emulsion is agitated with a sharp implement, it can be ruptured and the oil and water will separate. This is similar to the action of the film rupture chamber in the separator.

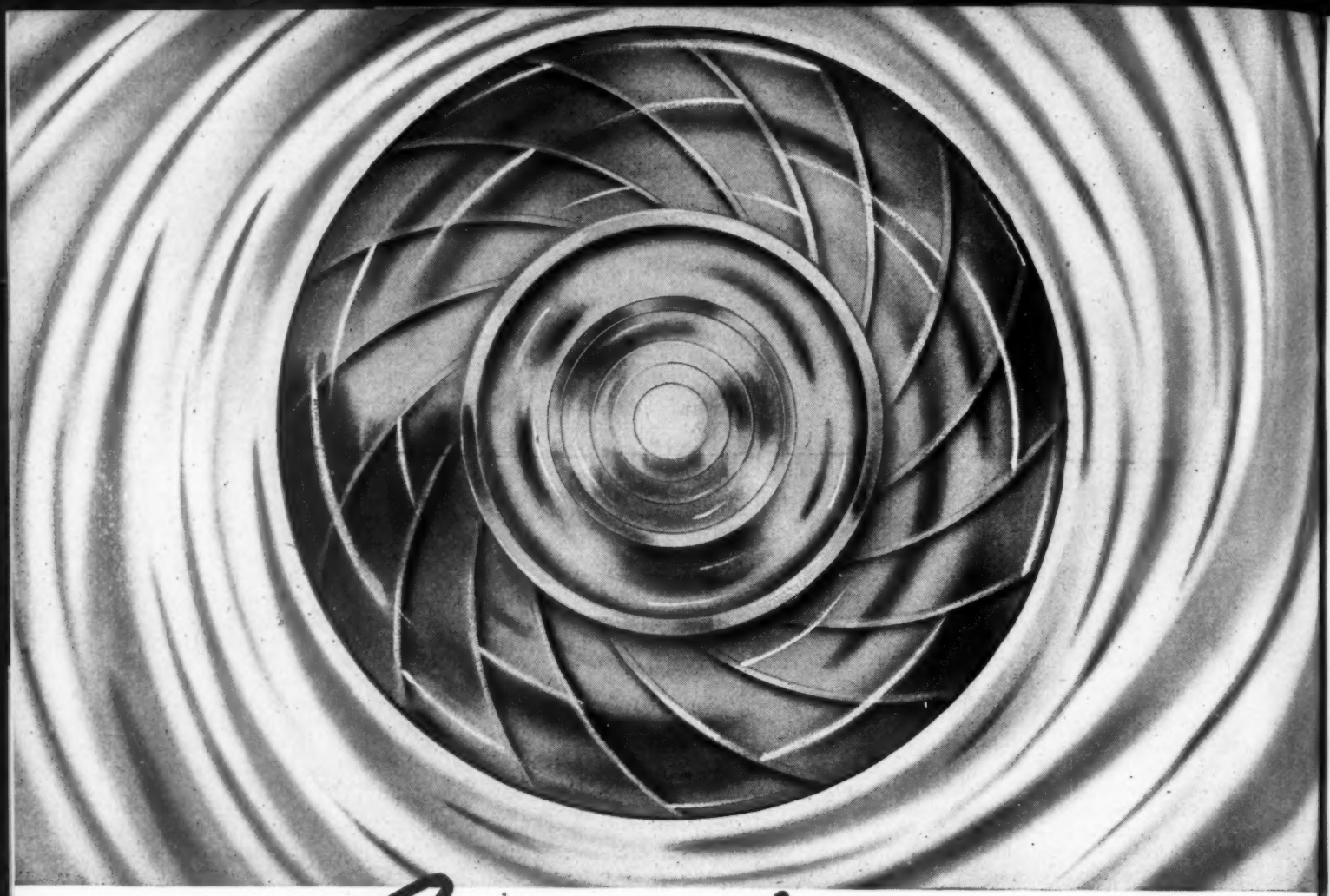
Emulsions of the water-in-oil type may require treatment either as they are flushed from a tank, or when they are a part of the collections from a separator. There are several treatment procedures possible. They are relatively simple, but are very useful around any refinery. They use heat, either alone or in conjunction with a treatment chemical. Often heat and some agitation will be successful.

Heat Treatment

The heat treatment procedure for breaking water-in-oil emulsions as applied in some refineries, requires only a number of tanks sufficient in capacity to permit time for accumulation of the emulsion and for heating and settling. Each tank should have well designed distributors for the introduction of steam (i.e., open steam). The tank roof should be equipped with ventilators in the form of hatches or other breathing devices to permit the escape of steam or vapors. It will be found economical to insulate the tank sides.

The operation is simple. Emulsion is accumulated in one of the tanks to a predetermined level which will permit room for some water from condensation. Meanwhile, the emulsion is accumulated in another tank for the purpose.

Steam is turned into the tank to be



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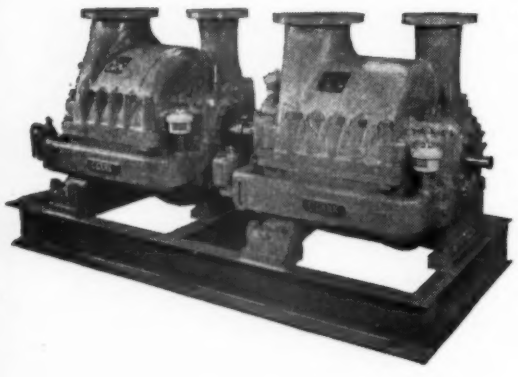

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treated, and continued until the temperature of the charge reaches 180° to 200° F. The introduction of the open steam provides all agitation necessary.

When the temperature has been held at the treatment level for a short time the steam is shut off and the tank content is permitted to settle. This settling period may extend for several hours. At the end of the period, the oil layer which forms above the water, is sampled at the top, the middle, and the bottom, and the samples are examined for content of "bottom settlings" and water. If these two components total less than 1%, the water layer is drawn off to a sewer which leads to a separator, and the reconditioned oil is sent to storage for rerun.

Not infrequently, a batch of emulsion may prove difficult to break by simple heat treatment. It is on such occasions that a plant arranged for both heat and chemical treatment demonstrates its value. Wherever emulsions of this nature are encountered, the latter type of treatment (i.e., heat and chemical) frequently will prove to be not only the most satisfactory, but also the most economical. Because of its flexibility, it will prove useful in treating emulsions from a variety of sources.

Combined Heat, Chemical Treatment

The arrangement of a plant for the combined heat and chemical treatment of emulsions of the water-in-oil type is approximately the same as shown in Fig. 3. The plant as shown in the figure provides for the continuous treatment of a rather extensive quantity of emulsion daily. It may be modified to suit conditions at any particular refinery. Those parts which are important functionally, however, are rather well established as to their relationships.

Emulsion, as it is moved from its source, may be charged directly into the treating plant, or the flow may be divided as necessary, part going directly to the treating plant and part to storage to be charged later. There should be ample storage capacity, for at times it may be necessary to move emulsions rapidly, and it probably will not be economical to design for treatment at such a high rate. Tank cleaning often will contribute to situations of this kind.

Heat is provided by exchange, using either exhaust or live steam, or a flow of hot material to be cooled if such a procedure is desirable. Chemical feed should be so arranged that it can either precede or follow heating. It is economical to use a special proportioning type of feeder. The introduction of the chemical should be followed by some form of mixing, and for this purpose the orifice type of mixer is quite satisfactory. Finally, a series of settling tanks is necessary, and it is much better to have several small tanks than just one or two large ones. By so doing, one tank can settle, entirely undisturbed, while the treated material is being discharged into another.

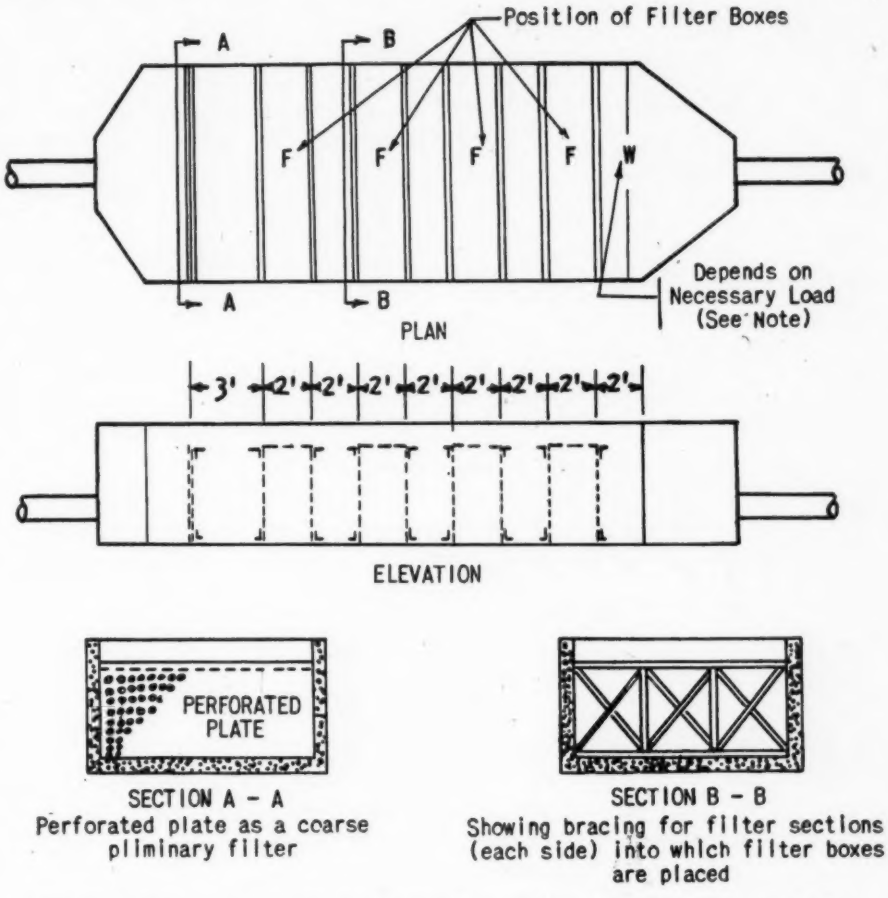
The amount of oil which can be salvaged from tank bottoms, emulsion from tank cleaning, and other sources, will surprise many who ordinarily send such material to some point to be burned. Often, the emulsion does not burn well and actually interferes with the efficient burning of other fuels. Even small refineries will find an emulsion treating plant of this type a desirable unit, for it provides a profitable disposal for a type of waste which otherwise may present a difficult problem.

Further Treatment of Effluents

Under some circumstances it may be necessary to remove oil so completely that there will be no iridescence or other indication of its presence in the waste water discharging from the refinery. Any method by which this degree of freedom from oil can be obtained will require that the major portion of the oil be removed first, and this best can be accomplished by gravity separation. Therefore, what is being discussed really is the matter of further treatment of separator effluents.

There are three procedures worthy of consideration when a high degree of oil removal is essential—simple filtration, bio-filtration and flocculation. These methods are arranged in an order of ascending degree of clean-up and also of cost.

Flocculation has already been dis-



TYPICAL WIRE BOX TO HOLD FILTER MEDIUM

Dimensions—2 ft. wide, 4 ft. long, 4 ft. deep. Boundary and cross braces are 2-in. angles. Loops arranged so box may be moved in and out of place readily

Fig. 5—Typical arrangement of a filter using salt marsh hay or glass wool as the filter medium

cussed in connection with the treatment of stable emulsions, and will not be given further consideration here except to point out that that method gives the ultimate in oil removal from separator effluents.

Simple Filtration

This procedure has greatest application where an abundance of salt marsh hay is available readily. This filtering medium has proved to be best for the purpose so far, although glass wool may make the method usable generally.

The most convenient application of the method is by means of the filter box as illustrated in Fig. 5. At least four filter sections should be used so that one section can be in process of renewal or cleaning at all times. Since the hay, or glass wool, is packed into boxes, there should be an arrangement such as an "A" frame or similar device by which the boxes may be removed from the filter box proper. When renewing the hay, or replacing any other medium which can be reused after washing, the medium should be placed in the frame and piled to about 18 in. above the top. It then can be pressed down until the frame cover can be closed. This procedure will give about the right filtration without too great loss of head, although other ways for gaging the hay density in the filter frame may develop from experience. The frames should be removed and repacked or cleaned as soon as iridescence appears on the filter effluent.

Filtration through hay depends for its effectiveness upon both adhesion and absorption. The oil globules are not really strained out as are grains of sand, for example. Consequently, the hay becomes saturated with oil. There is not enough to warrant recovery, however, so every hay filter installation should be provided with a good, safe incinerator in which the oil-soaked hay can be destroyed quickly. There is no experience with glass wool to indicate how it may be washed or otherwise handled. Experimentation as to its effect as a filter medium is being planned, and the development of a continuous, self-cleaning filter, using a cloth-like medium, is under way at present.

Simple sand filters are practicable for small plants where the quantity of flow is such that a great area of filter is not required. The design of a satisfactory filter can be based upon a capacity of 1.5 gal./sq. ft./min. A factor of 2 gal. may be used when the effluent is relatively free of suspended matter, but this figure never should be exceeded.

It will not be necessary to design the filter for back-washing as in water plants, although back washing may be used to advantage in some installations. A much simpler procedure is to scrape off the top few inches of sand and replace with clean sand when the filter shows signs of plugging. The sand which has been used may be burned free of oil and discarded. A carefully burned-off sand has been made reusable with satisfactory results by rubbing through a sand screen to size it properly. All data and sketches for the design of a simple sand filter are shown in Fig. 6. Where back washing is to be employed the equipment vendor should be consulted.

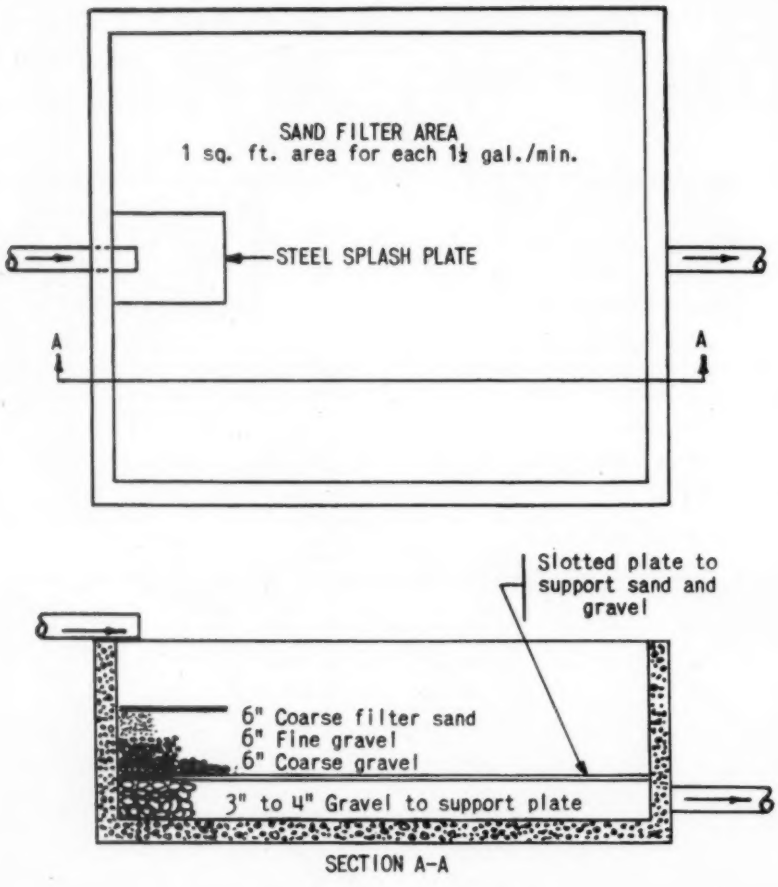


Fig. 6—Details of a simple sand filter

Bio-Filtration

Before concluding the articles on waste oils and emulsions, it is desirable to mention one other type of equipment which, although it will break some emulsions, is more adaptable to treating separator effluents for the elimination of small quantities of emulsion and free oil which may cause irridescence. This is the trickling filter or biofilter. It also has another very important application, and that is in the reduction of the oxygen demand of wastes. The application of biofilters to refinery waste treatment is in the developmental stage. Its practicability has been established, however, and its overall effectiveness will be reported later.

* * *

With the foregoing discussion on the treatment of emulsions we come to the conclusion of this series of articles dealing with refinery waste disposal problems.

From the interest created by Mr. Hart's articles, both within and outside the refining industry, it is evident that they are filling a long-felt need for up-to-date information on this vital subject. It is the sincere hope of the staff of PETROLEUM PROCESSING that they will be instrumental in not only making refiners more fully aware of their responsibility but also in helping them solve their waste disposal problems.

THE EDITORS

References
(174) "Sewage Treatment Works," by C. E. Keefer, Chap. IX, pg. 673, McGraw-Hill Book Co., New York (1940).

Reprints Available Soon

Reprints of the entire series of articles by W. B. Hart on "Waste Disposal" including this final article, No. 20, will be made available in book form. It will be complete with all references and illustrations, as published in PETROLEUM PROCESSING, and its predecessor, the *NPN Technical Section*. The book will be 8½ x 11 in. in size and will have stiff cloth binding to assure durability. Copies can now be ordered at $4.00 each, postpaid, for delivery about the 15th of October. Address your request to:

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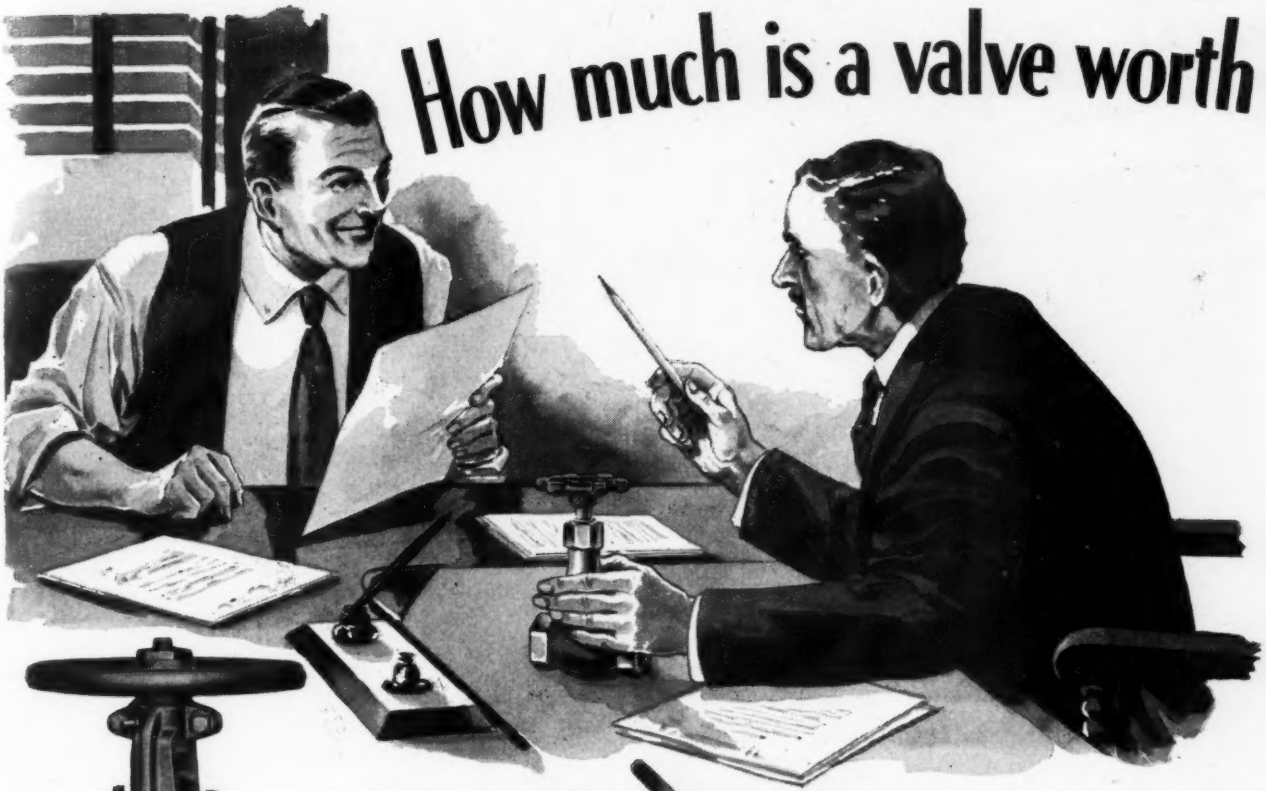

Fig. 1314-A—Class 1500-pound Steel "Y" Valve. Has integral bonnet and welding ends.

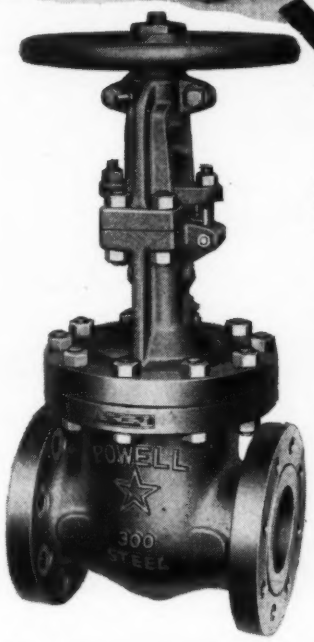

Fig. 3003—Class 300-pound Cast Steel Gate Valve with flanged ends, bolted flanged yoke, outside screw rising stem and taper wedge solid disc.

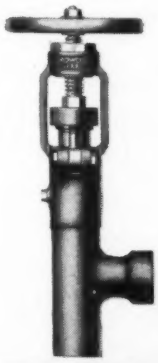

Fig. 1503—Class 150-pound Cast Steel Gate Valve with flanged ends, bolted flanged yoke, outside screw rising stem and taper wedge solid disc.

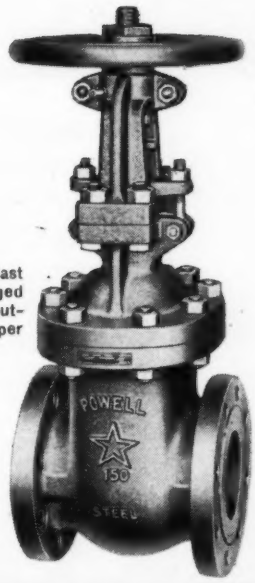

Fig. 1333-A—Class 1500-pound Steel Angle Valve. Has integral bonnet and welding ends.

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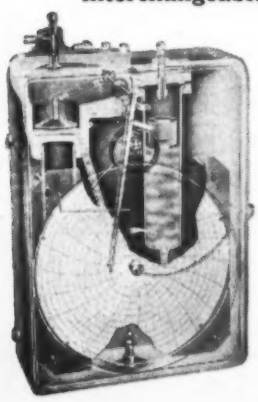

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Patent Trends in Petroleum Refining

By Peter J. Gaylor

Patent Attorney and Editor "The Technical Survey"

Developments disclosed in the patents reviewed below include:

A process for producing adsorbent gels in spherical form.

Extracting aromatic hydrocarbons from aliphatics and naphthenes.

Reduction and control of pipeline corrosion.

Spherical Catalysts

NOW that catalytic cracking has established itself, various developments are taking place in the production of shaped catalysts due to advantages gained in abrasion resistance, ease in handling, etc.

One of the first patents on the production of shaped catalysts is U. S. 2,284,248 issued to Philadelphia Quartz Co. This patent disclosed the dropping of formed hydrogel particles into acetone and similar liquids which would tend to dehydrate the particles. Some time after that came the Socony bead catalyst patents, as exemplified by U. S. 2,384,455 and 2,384,942-5. The process employed was discussed in this section some months ago.

Recently, a patent (2,422,499) was issued to Standard Oil Development Co. on a process for producing adsorbent gels in spherical form in sizes of 0.25 mm. up to about 5 mm. diameter. Such "microspheroidal" particles are produced by a simple process, such as that illustrated by Fig. 1. A sol of the desired gel (in this case, alumina) is prepared and stored in tank 1, from which it is fed through distributor head 5 at the top of tower 3 filled with kerosene or other water-immiscible liquid maintained at 200-212° F. The sol particles lose their water as they drop down the tower and firm gel spheres are produced by the time they reach the water layer at the bottom of the tower, forming interface 8 with the oil.

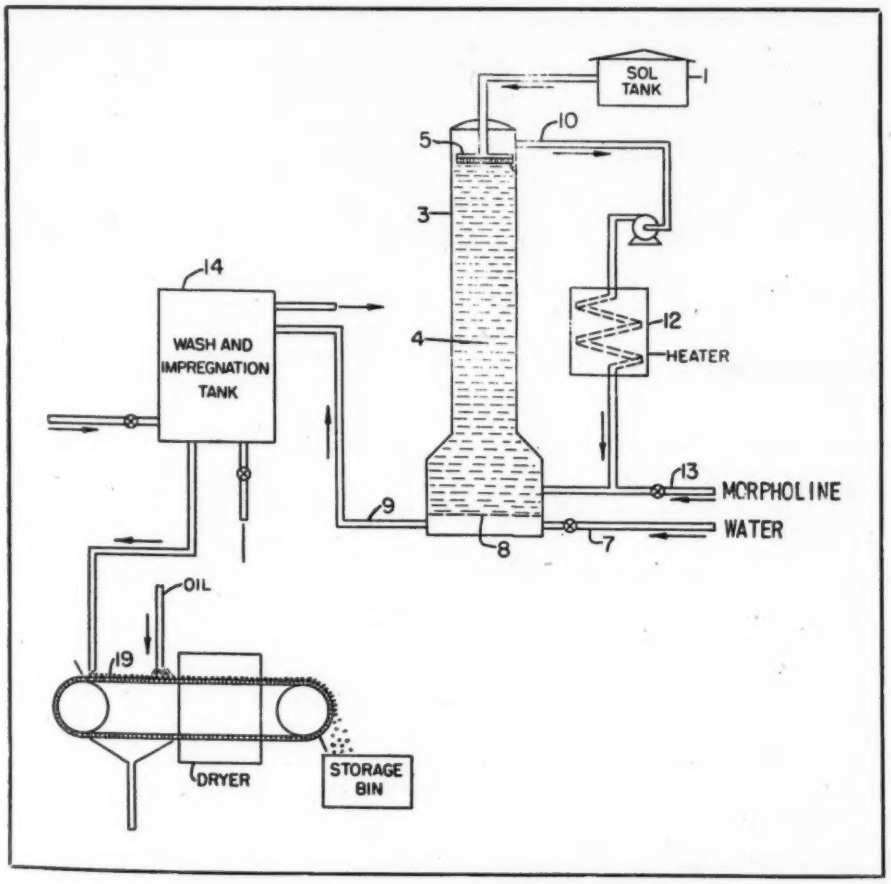


Fig. 1—Flow diagram for method of Standard Oil Development Co. (U. S. 2,422,499) for producing microspheroidal catalyst particles

The particles are forced through line 9 by water flow from pipe 7 and led into tank 14 where they are washed and possibly impregnated with metal salts, after which the particles are passed to an endless belt screen 19 for drying subsequent to spraying with some oil from pipe 21 to prevent decrepitation during drying.

The oil in tower 3 may be drawn off the top through line 10, and pumped through heater 12 and recycled back to the bottom of the tower. Compounds such as morpholine may be added through line 13 for adjusting the pH of the gel.

Extraction of Aromatics

A METHOD for extracting aromatic hydrocarbons from aliphatics and naphthenes by the use of a novel halide complex solvent is disclosed in The Texas Co.'s patent 2,412,828.

The feed hydrocarbon mixture of aromatics and non-aromatics is contacted with an aluminum halide-hydrocarbon complex of the Friedel-Crafts type. The contacting is done under conditions so as to form a primary extract phase containing complex aromatic hydrocarbons and some non-aromatic hydrocarbons, while the primary raffinate phase consists essentially of non-aromatic hydrocarbons such as paraffins and naphthenes. The raffinate is discharged and the extract is subjected to contact with a wash solvent under conditions so as to displace non-aromatic hydrocarbons present in the extract, thereby leaving a secondary extract consisting of complex aromatic hydrocarbons and a small amount of wash solvent. This secondary extract is then contacted with more wash solvent to displace, from the complex, a highly concentrated aromatic fraction.

The process is especially applicable to separating aromatics from feeds containing 10-80% aromatics. The solvent is an aluminum chloride-hydrocarbon complex having a heat of hydrolysis of 290-330 small cal./gm. complex, and prepared by reacting $AlCl_3$ with kerosene in presence of HCl at 200-250° F.

A feature of the process has to do with the separation of aromatic hydrocarbons from non-aromatic hydrocarbons which are coextensive in boiling

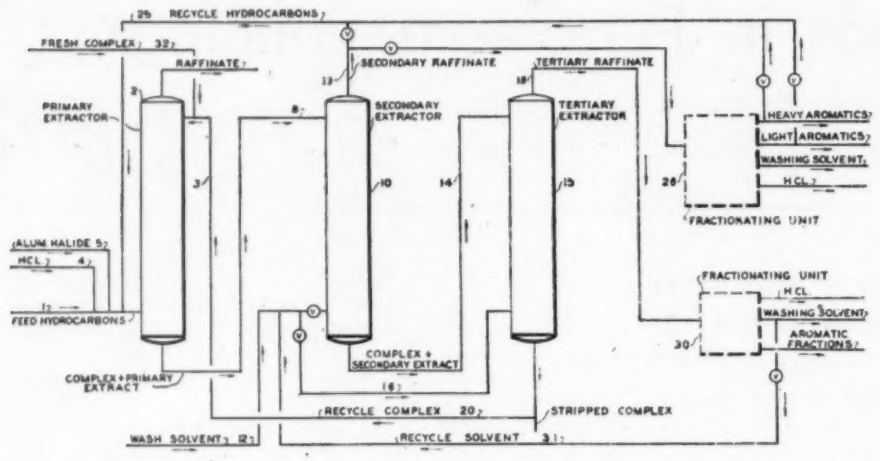


Fig. 2—Flow diagram for method of extracting aromatic hydrocarbons from aliphatics and naphthenes by the use of a halide complex solvent. (The Texas Co., U. S. 2,412,828)

range. Aluminum halide-hydrocarbon complexes exert a high degree of solvent action upon aromatic hydrocarbons, and this solvent action may involve some combination between the aluminum halide and aromatic hydrocarbons. However, non-aromatic hydrocarbons also tend to form combinations with aluminum halide, but these latter combinations are apparently of more loose character than the aromatic complex combinations.

It has been found that the paraffin and naphthene hydrocarbons retained in the extract phase can be displaced by washing the extract with a saturated hydrocarbon of different boiling range, outside of the range of the retained hydrocarbons. These washed extracts can then be subjected to further washing with larger amounts of solvent, to displace aromatics from the complex which, after it is stripped of aromatics, can be recycled for extraction of fresh feed.

The process may be more readily understood by reference to Fig. 2. Feed entering tower 2 through line 1 is mixed with halide 5 and HCl from line 4, as well as recycle hydrocarbons from line 25. In tower 2, this mixture is extracted counter-current to recycle complex coming from line 3 and fresh complex from line 32. The primary extract containing the complex, leaving through line 8 is passed into the top of secondary extraction tower 10, counter current to wash solvent from line 12 and recycle solvent from line 31. The secondary raffinate 13 is then run into fractionating unit 26 for aromatic recovery, while the complex and secondary extract leaving the bottom of the tower through line 14 is fed into the top of tertiary extractor 15, counter-current to a stream 16 which is part of feed to tower 10. The recycle complex 20 leaving the bottom of tower 15 is run to tower 2, while the tertiary raffinate 18 is sent to fractionating unit 30 for recovery of washing solvent and aromatic fractions.

The process is advantageously employed in conjunction with isomerization or reforming of xylenes.

Pipeline Corrosion Inhibitors

STANDARD Oil Co. of Indiana has found that the corrosion of pipelines carrying petroleum products can be reduced and controlled by adding to the line very small amounts of a water solution of *sodamide*. In one test, the base rate of corrosion during 40 hrs. without inhibitor was 0.0210 in./yr., whereas, with the addition of 1.8 lbs. sodamide per M bbls. of gasoline, the corrosion rate was reduced, during 384 hrs., to 0.00271 in./yr. The corrosion rate with inhibitor was found to fall off with time, indicating that continued use of inhibitor in pipeline corrosion prevention becomes increasingly effective. No pitting was observed in the test.

Selected Patents of the Month

U.S. 2,423,760 (Standard Oil Development)—Polymerizing isobutylene.

U.S. 2,423,789 (L. Sonneborn Sons)—Pour point depressant containing Al stearate, etc.

U.S. 2,423,795 (Standard Oil Development)—Separating acetone and hydrocarbons by azeotropic distillation.

U.S. 2,423,833 (Foster Wheeler)—Applying Cr compound to spent Super Filtrol in fluid cat. cracking.

U.S. 2,423,835 (Houdry Process)—Inert heat material in contact mass catalysis.

U.S. 2,423,844 (Cities Service Oil)—Time piece lubricant containing tricresyl phosphate, ethylene glycol monoethyl ether ricinoleate and triethylene glycol di-2 ethylbutyrate.

U.S. 2,423,845-6 (Standard Oil Development)—Isomerization.

U.S. 2,423,850 (Shell Development)—Catalytic conversion system.

U.S. 2,423,865 (Shell Development)—Corrosion preventive.

U.S. 2,423,907 (Phillips Petr.)—Catalytic conversion.

U.S. 2,423,913 (Sun Oil)—Composite fuel.

U.S. 2,423,927 (S. O. Ohio)—Constant viscosity hydraulic fluid.

U.S. 2,423,947 (S. O. Ind.)—Catalytic reforming.

U.S. 2,423,949 (Shell Dev.)—Acetic acid by photochemical oxidation of ethane with oxygen.

U.S. 2,424,074 (Shell Dev.)—Tall oil ester resin.

U.S. 2,424,083 & 5 (Shell Dev.)—Supported silver catalyst.

U.S. 2,424,084 & 6 (Shell Dev.)—Olefin oxides by oxidizing ethylene.

U.S. 2,424,147 (Standard Oil Development)—Controlling catalyst-oil ratio by use of a venturi.

U.S. 2,424,152 (Standard Oil Dev.)—Titania gel-boria catalyst.

U.S. 2,424,158 (Standard Oil Dev.)—Refining petroleum oil containing naphthenic acids by alkylol amine extraction.

U.S. 2,424,186 (Standard Oil Dev.)—Selective extraction if isobutylene with sulfuric acid.

Can. 442,427-30 (American Cyanamide)—Lube oils containing salicylic phenol sulfides.

Can. 442,500-1 (Shell Development)—Photochemical preparation of thioethers.

Brit. Appl. 10,140/47 (Calif. Research Corp.)—Aliphatic olefins.

Brit. Appl. 12,788/47 (Universal Oil Products)—Surface active agents.

Brit. Appl. 13,401-3/47 (Houdry Proc.)—Organic compounds.

Brit. Appl. 14,326/47 (California Research)—Demethylating methyl benzenes.

Brit. Appl. 14,293-4/47 (Clark Bros.)—Oxidation of hydrocarbons.

Brit. Appl. 14,286/47 (Standard Oil Development)—Oxo synthesis.

Brit. Appl. 14,053-7 (Texaco Development)—Separation of organic compounds.

Brit. Appl. 14,621/47 (Anglo Iranian Oil)—Acetylene recovery.

Brit. Appl. 15,356/47 (Shell)—Viscous liquid heating process.

Brit. Appl. 15,543/47 (Shell)—Aluminum soap greases.

Brit. Appl. 15,544/47 (Shell)—Halogenation.

Brit. Appl. 17,477/46 (Shell Dev.)—Unsaturated alcohols.

Brit. Appl. 30,585/46 (Shell)—Increasing polymerization rate of diallyl phthalate.

Brit. Appl. 31,389/46 (Calif. Research)—Sulfur compounds.

Brit. Appl. 31,963/46 (Standard Oil Dev.)—Gel catalysts.

Brit. Appl. 33,753-6/46 (Hydrocarbon Research)—Oxygen.

Brit. 586,829 & 31 (Usines de Melle)—Olefin hydration.

Brit. 587,161 (Shell)—Catalysts.

Brit. 588,099 (Shell Dev.)—Phenolic compounds.

Brit. 588,461 (Standard Oil Calif.)—Multicylinder engine detonation measurement.

British 588,864 (Wakefield & Co.)—Additive lubricating oils.

British 588,765 (Anglo Iranian)—Refining hydrocarbons.

British 589,149-50 (Lobitos Oilfields)—Insulating oils.

Austral. Appl. 11,208/47 (Distillers Co.)—Alkyl benzene peroxides.

Austral. Appl. 11,189/47 (Union Oil)—Lubricants.

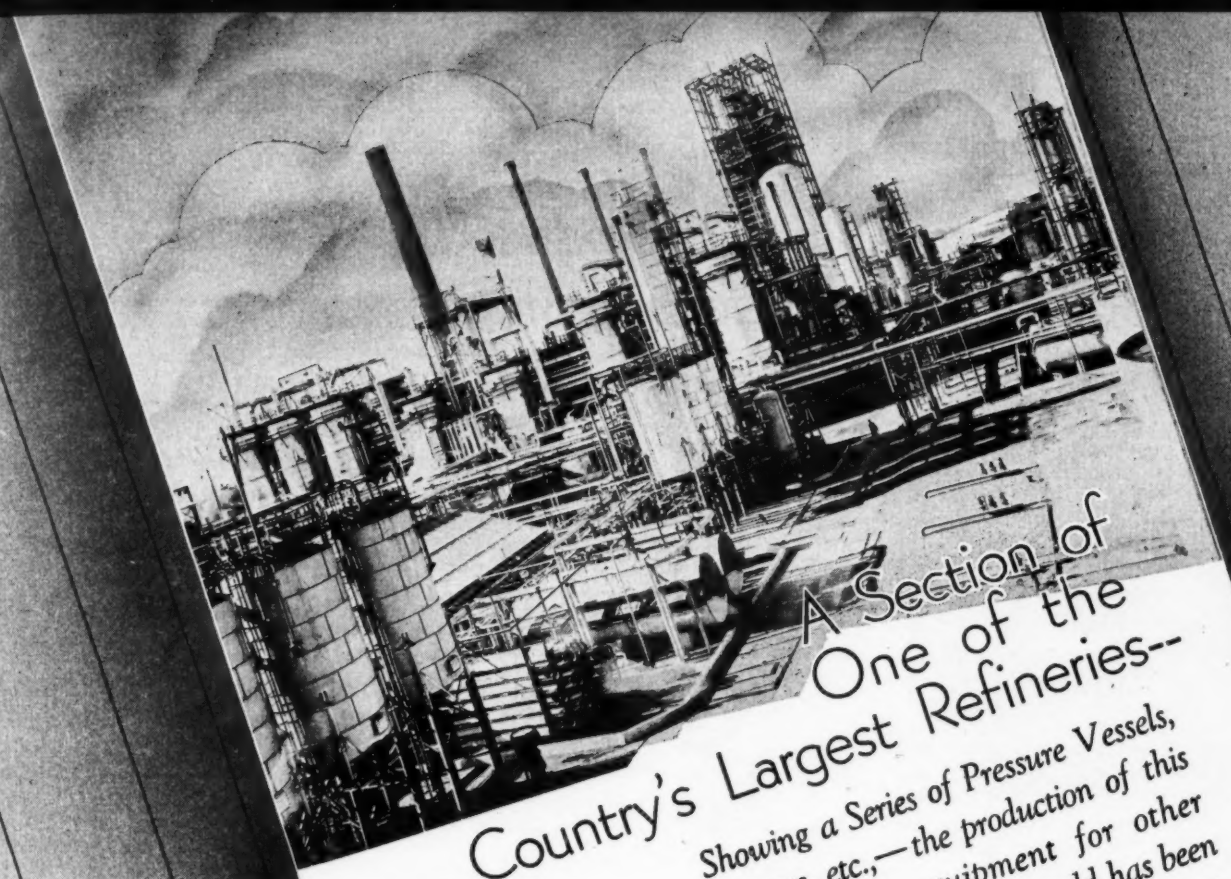
Austral. Appl. 11,614/47 (California Research Corp.)—Aryl substituted alkanes.

Austral. Appl. 11,615/47 (California Research Corp.)—Aliphatic olefins.

Austral. Appl. 11,616/47 (California Research Corp.)—Detergents.

Australian S.P. 124,018 (Shell Dev.)—Silicone antifoamers.

Australian S.P. 124,214 (Anglo Iranian)—Recovery of 1,2,3-trimethyl benzene.



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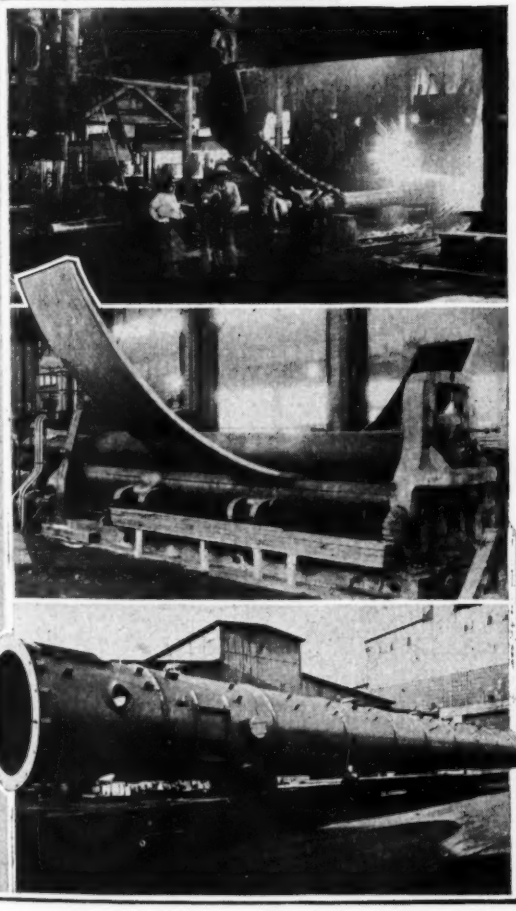

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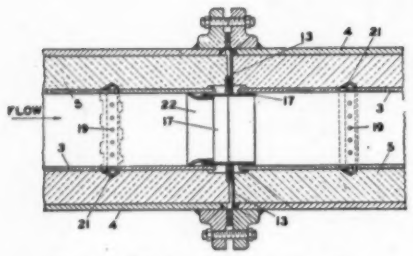


Fig. 1—High temperature pipe (2,243,213)

HIGH TEMPERATURE conduit combining the advantages of alloy steels, ordinary steels, and insulating material is reported to have shown particular utility as low cost equipment for refinery operations.

The construction is shown in Fig. 1. Low carbon steel outer shell 4 is secured to adjacent lengths of identical construction by conventional flanges. Inner shell 3 is made of alloy steel, as is annular baffle 13, flanged sleeves 17, and flared nipple 22. Insulating material 5 is cut or molded to fit.

To provide for pressure fluctuations within the inner pipe, there are a series of breather holes 19. Covering these holes is stiffener ring 21, spot welded as shown at the left, or continuously welded along one side only, as shown at the right, thus allowing free release of fluid pressure.

In operation, flow is indicated by the arrow. Hot gases penetrating space 5 dissipate their heat before reaching outer shell 4. Annular baffles 13 prevent channeling and return the gases to the inner conduit 3. Lengths of this type of piping can easily be taken out by removing flange bolts. Some previous insulated pipe, made with telescoping portions, did not offer this simplification in maintenance, it is said.

U. S. 2,423,213, issued July 1, 1947, to L. J. Weber, assignor to the Phillips Petroleum Co.

Exchanger Efficiency Increased By Change in Ferrule Design

IMPROVED DESIGN of distribution ferrules is said to provide for more even distribution of cooling liquid through each tube in vertical heat exchangers, and prevents occurrence of the undesirable turbulence encountered in conventional ferrules.

The design is shown in Fig. 2. Flange 9 fits over the end of the tube as it comes through the upper tube sheet, section 10 fitting lightly within the tube. The distribution baffle 16 is suspended below the opening 12 on posts 17. The upper surface of the baffle descends symmetrically in all directions from a peak which is in the axis of bore 12.

U. S. 2,424,441, issued July 22, 1947, to Eugene A. Edmonds, assignor to Henry Vogt Machine Co., Louisville, Ky.

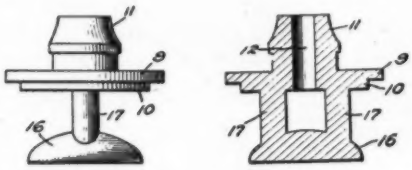


Fig. 2—Ferrule (2,424,441)

Expensive Machining Is Avoided With New High Pressure Union

EXPENSIVE MACHINING is avoided and efficient sealing at high pressures is obtained in a new pipe union in which the packing unit can be replaced without spreading the coupling members apart. The union is shown in Fig. 3.

The packing unit consists of an inner metal shield ring 24, a flexible seal ring 25, preferably synthetic rubber, and an outer metal retaining ring 23. All three rings are of substantially the same thickness; however, the thickness of ring 24 is slightly less than that of ring 23, thus causing it to become, in a slight degree, a floating ring.

In this way, a small amount of pressure fluid will by-pass the main channel and come into contact with seal ring 25. It will expand lips 28 and 29 of the ring forming a fluid-tight seal in the union. In use, the fitting need only be tightened enough to bring faces 15 and 19 into thorough contact with retaining ring 23.

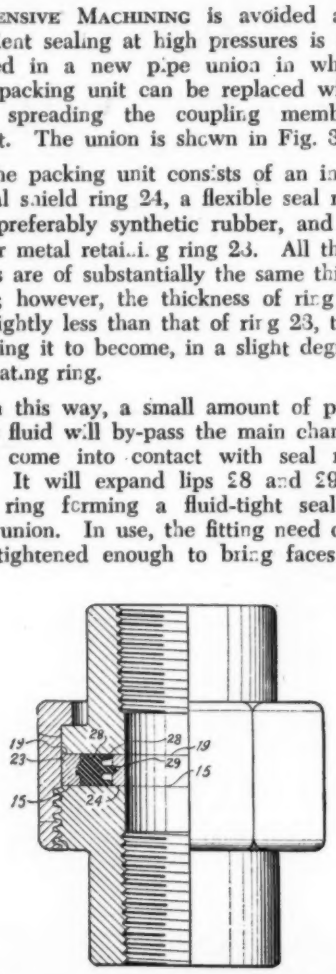


Fig. 3—High pressure union (2,421,659)

U. S. 2,421,659, issued June 3, 1947, to William J. Sutton and Benjamin C. Simpson, assignors to Wilson Supply Co., Houston, Texas.

Sticking Vanes Are Eliminated In Improved Rotary Pumps

STICKING VANES are said to be eliminated in a new design for a rotary pump which supplements the centrifugal force from the rotor rotation with pressure by the fluid being pumped.

The rotor is shown in Fig. 4, and two views of the vane in one modification of the invention are shown in Fig. 5. Slots 31 are cut at an angle to any radius of the rotor, which revolves in a clockwise direction as pictured. A flat section 32 is cut away at the forward edge of each slot.

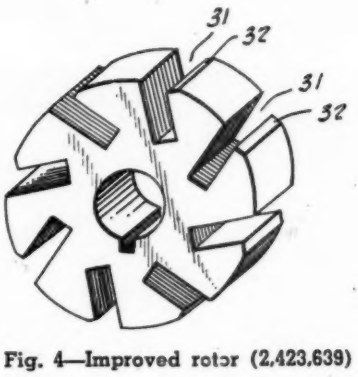


Fig. 4—Improved rotor (2,423,639)

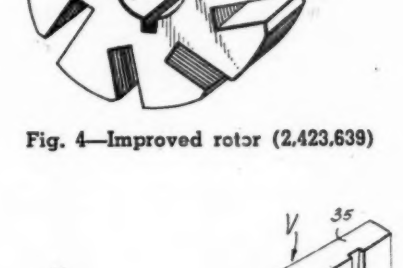


Fig. 5—Improved vane (2,423,639)

Vane 35 in Fig. 5, has a pair of channels 38 cut vertically in its leading, or forward, face, 33. The channels lead to groove 39 on the under, or inside, face of the vane.

In operation, clockwise rotation of the rotor tends to force the vanes outwardly against the inner wall of the conventional pump casing. This tendency is supplemented by the force of fluid flowing through channels 38 into the space in the slot under the vane, thus breaking any seal or partial vacuum.

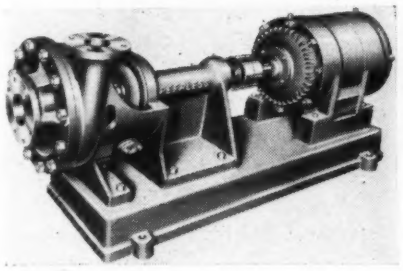
U. S. 2,423,639, issued July 8, 1947, to Walter Czarnecki, assignor to Eddington Metal Specialty Co., Eddington, Penna.

What's New!

Edited by
WILLIAM C. UHL
Equipment Editor

EQUIPMENT . . . MATERIALS . . . PROCESSES . . . LITERATURE

1—Acid or Caustic Pump



The Type ACO centrifugal pump for acids and caustics incorporates a number of features suggested by industrial users of such equipment. Pump volute and drip pocket comprise one integral casting: stuffing box leaks therefore drip onto material capable of withstanding corrosion. A large inboard end cap of special alloy prevents liquid being handled from reaching the bearing housing. Volute vents through a passage cast integral with pump case which vents into the pump discharge. The conventional screw type fitting in the drip pocket has been replaced by flange and two bolts which can be made of stainless steel. The stuffing box contains 7 rows of packing in addition to the water seal lantern ring. The pump is of single stage, single suction type, handling up to 600 gpm against heads up to 200 ft. Peerless Pump Division, Food Machinery Corp.

2—Cast-Steel Trap

A new line of cast-steel thermostatic steam traps with the patented Sarco helical bellows is being offered for severe conditions of service. The cast-steel body and cap is said to provide needed strength to withstand shock of external explosions. Stainless steel thermostatic element enables handling of corrosive condensate and permits the traps to be used for superheat or for a maximum operating pressure to 300 psi. Also available with bronze element for pressures to 225 psi. saturated steam. Sizes are ½, ¾, 1, and 1¼ in. Sarco Co., Inc.

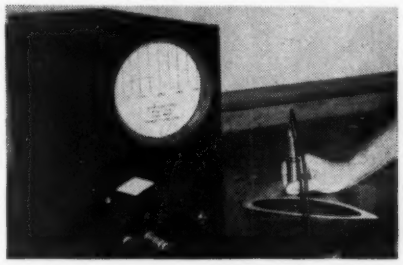
For More Information

Use one of the attached business reply cards, which requires no postage, to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the bottom of the card, and drop it in the mail.

3—Instrument Air Dryer

Available in off-the-shelf units as standard models is a new line of "Dehydraire" instrument air dryers which will dry the air for 25 to 500 air-operated instrument installations. They have a capacity range of 12½ to 250 SCFM at 100 psi. and 70° F. Final dew point of air leaving the Dehydraire unit will be as low as −50° F. Units are built for either single or polyphase reactivation or steam reactivation where steam pressures of 100 psi. or over are available. They are available for either manual or automatic reversal on an 8-hour cycle. For refineries or other hazardous locations, all electric equipment will be Class 1, Group D, explosion-proof construction at slight extra cost. Units for handling 25 to 100 instruments are totally enclosed cabinet models; those for 150 to 500 instruments are of open tower design with a front operating panel. Dehydraire Corp.

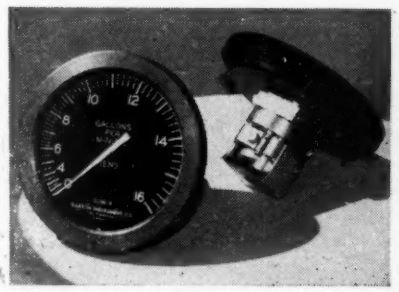
4—Thickness Measurement



Thickness of metals and other materials can be measured where access from only one side is available by means of the "Reflectogage," a new instrument utilizing supersonics. Maximum error is said to be less than 2% of thickness. Thickness of tubing and flat parts between 0.005 and 0.300 in. can be read directly from the face of the oscilloscope screen. Indirect reading of thicknesses up to four in. can be accomplished with slight calculation. Sperry Products, Inc.

5—Indicator

The Model 181, an improved Differential Pressure Indicator for the measurement of flow, liquid level, and pressure differentials features a six inch dial for greater visibility, universal mounting for wall, flush panel, or pipe stand, vaporproof case, and wide differential pressure range (0-50 in. of water up to 0-200 psi). Constructed of drawn bar stock, it has brass rupture-proof bellows with static pressure rating up to 3000 psi. Size of the indicator is 7½ in. diameter and 4½ in. deep. Barton Instrument Co.



More "What's New!" Items on Page 707

new, all-purpose gear lubricant additive SANTOPOID 29

When blended with suitable base oils, Santopoid 29 — Monsanto's new gear lubricant additive — provides *in a single gear lubricant* the performance characteristics necessary for properly lubricating hypoid and other gears under the severe operating conditions of high-speed passenger cars, heavy-duty trucks, tractor-trailers and busses.

Specifically, Santopoid 29 will add these advantages:

1. Provides outstanding lubricants for automotive differentials and conventional transmissions.
2. Provides outstanding lubricants for heavy duty industrial type gear units in other commercial applications, such as production machinery, conveyers, etc.
3. Allows the refiner and compounder to simplify gear lubricant and additive inventories.
4. Is stable and non-corrosive at any temperature likely to be reached in service.
5. Does not separate from a lubricant or stratify; contains no metals that may form precipitated salts.

Santopoid 29 has been qualified by the U. S. Army Ordnance Department under U. S. Army Specification 2-105B at a concentration of 6.5% by weight. When used in this concentration it does not markedly affect the properties of the base oil with which it is blended.

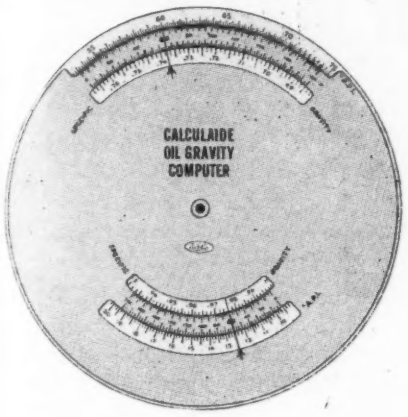
Further information and technical data on Santopoid 29 is available — write for Technical Bulletin O-47. MONSANTO CHEMICAL COMPANY, Petroleum Chemicals Department, 1700 South Second Street, St. Louis 4, Missouri. On the West Coast contact District Sales Offices in Los Angeles, San Francisco, Seattle. In Canada: Monsanto (Canada) Limited, Montreal.

Santopoid: Reg. U. S. Pat. Off.

MONSANTO
CHEMICALS AND PLASTICS

SERVING INDUSTRY . . . WHICH SERVES MANKIND

6—Gravity Computer



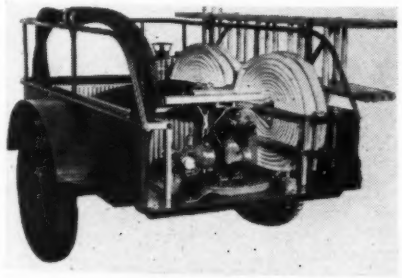
The "Calculaide" accurately corrects API gravity readings at any temperature to API gravity at 60° F., and also indicates corresponding specific gravity value for any API gravity. A flat disc, 7 in. in diameter, it is made of oil-resisting plastic, and comprises two temperature scales—one for oils ranging from 0 to 32° API and temperature indications 0 to 200° F., the other for oils ranging from 28 to 100° API and temperatures from 0 to 180° F. The Emil Greiner Co.

7—New Additive

A new glycol, 2-methyl-1, 3, pentanediol, is expected to find wide industrial use in oils, greases, lubricating oils, hydraulic fluids, penetrants, soaps, and detergents. It contains one primary and one secondary hydroxy group and is said to be miscible with most organic solvents. Boiling pt. is 215° C. It has a limited solubility in water (no parts to 100 parts water). Available in experimental quantities for product evaluation. Celanese Chemical Corp.

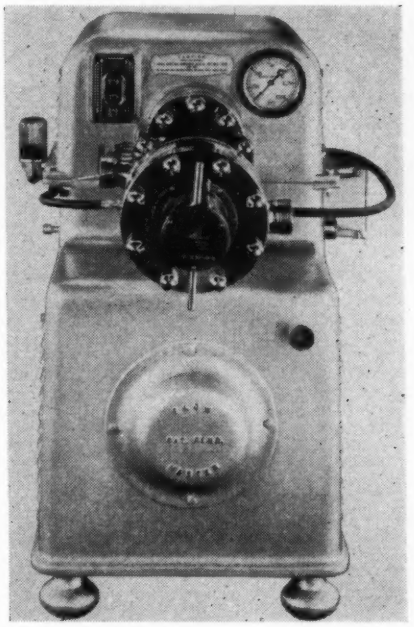
8—Fire Fighter

The "Porto-Pumper" portable pumping and fire-fighting unit features a gasoline engine-driven pump which is held in position at the rear of the trailer by a patented locking device and is demountable in a fraction of a second.



The pump and engine may then be used at any distance from the trailer as an independent unit. A webfoot base plate prevents sinking into soft ground. The Porto-Pumper itself, easily attached to auto, jeep, or truck, carries a 48 by 78 in. steel box body mounted on heavy duty tires of standard automobile center-to-center track. Pump delivers 40 gpm at 120 psi. Equipment includes 50 ft. of supply hose, 250 ft. of 1½ in. canvas fire hose in 50-ft. lengths, an 18-ft. three section, extension ladder, fire axe, and a hand type extinguisher. Porto-Pump, Inc.

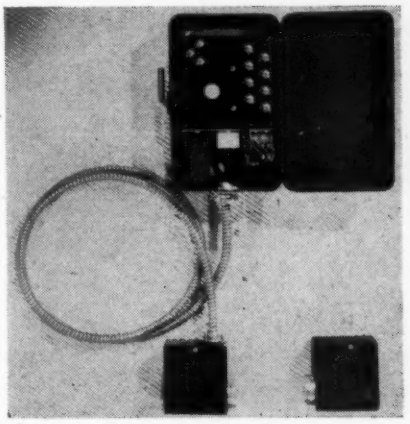
9—Grease Maker



The Flow-Master Process is a continuous method for manufacturing greases and blending oils, said to be completely automatic, and able to produce a homogeneous product. Standard capacities range up to 1000 gals./hr. Special units can be furnished in capacities to 3500 gals./hr. Feature of the process is the Temperer (shown in the photograph) which blends, mills, and homogenizes the ingredients under automatic temperature control. Marco Co., Inc.

10—Photoelectric Control

With an operating range of 10 ft., the Photoelectric Control, Type 20DJ1, provides for relay operation in 1/20 sec. at any predetermined level of illumination within the range of 10 to 50 foot candles. Specifically designed for industrial use, it is recommended for counting, conveyor control, automatic weighing, etc., even under conditions of ambient light. It operates on a supply of 115 and 230 volts—50/60 cycles A.C. Photoswitch, Inc.

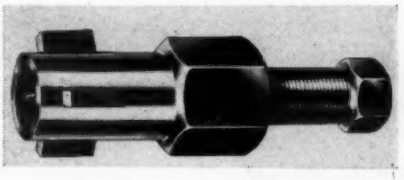


11—Corrosion Inhibitor

Morpholine, an organic alkaline compound that inhibits corrosion caused by carbon dioxide in steam and condensate-return lines of steam-heating or processing systems, is again available after several years' shortage during the war. It is suggested for the treatment of feedwater for boilers supplying low or medium pressure steam to systems with extensive piping or condensing surfaces. Carbide and Carbon Chemicals Corp.

12—Internal Wrench

The B & D Internal Wrench will remove broken pipe, close nipples, gate and globe valve seats, and is claimed to have sufficient strength to strip a thread without losing its grip. It consists of a screw type mandrel that forces outward three gripping dogs until they bite firmly into the inside of the pipe. Any standard wrench will then turn the B & D Wrench. It may be used on nickel, chrome, or brass fittings. Dogs are made of hardened tool steel, and body is high tensile strength steel alloy. Tool is available in 8 sizes from ½ to 6 in., sold separately or in sets. Porst Sales.



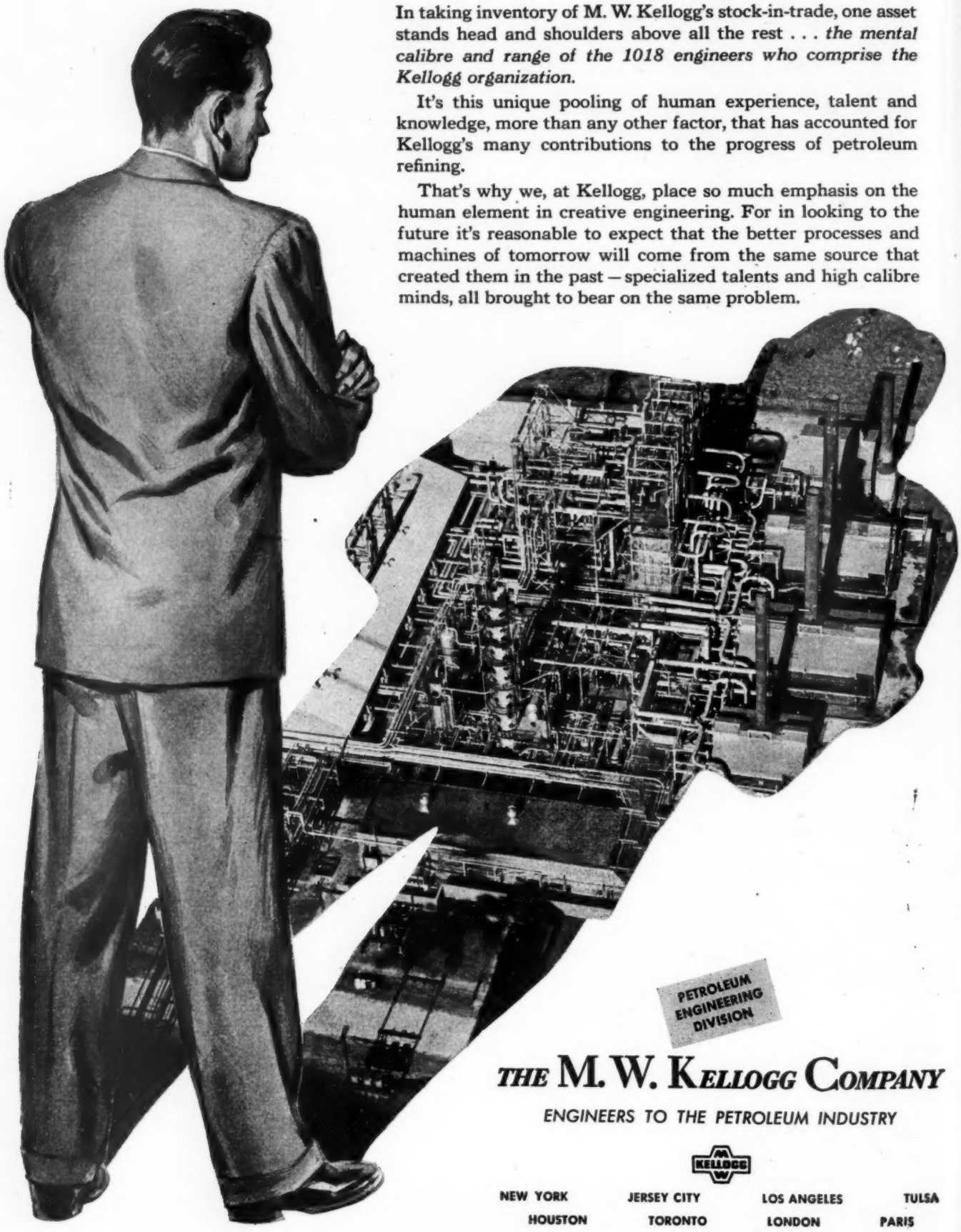
More "What's New!" Items on Page 709

Shadow of an Idea

In taking inventory of M. W. Kellogg's stock-in-trade, one asset stands head and shoulders above all the rest . . . *the mental calibre and range of the 1018 engineers who comprise the Kellogg organization.*

It's this unique pooling of human experience, talent and knowledge, more than any other factor, that has accounted for Kellogg's many contributions to the progress of petroleum refining.

That's why we, at Kellogg, place so much emphasis on the human element in creative engineering. For in looking to the future it's reasonable to expect that the better processes and machines of tomorrow will come from the same source that created them in the past — specialized talents and high calibre minds, all brought to bear on the same problem.



PETROLEUM ENGINEERING DIVISION

THE M. W. KELLOGG COMPANY

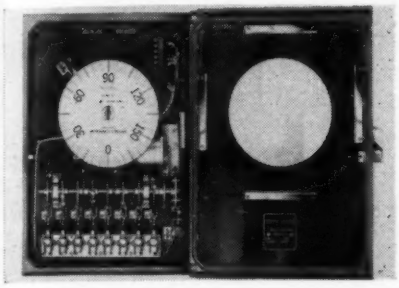
ENGINEERS TO THE PETROLEUM INDUSTRY

KELLOGG

NEW YORK JERSEY CITY LOS ANGELES TULSA

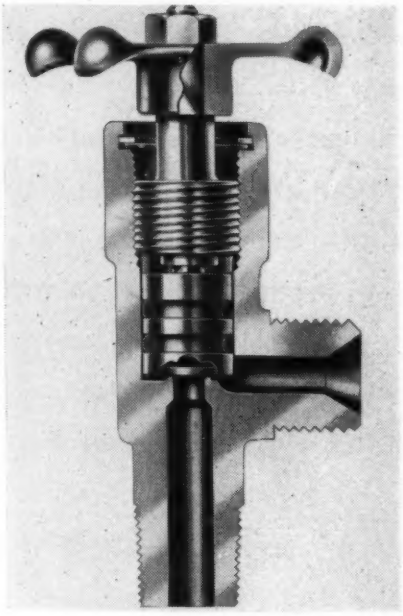
HOUSTON TORONTO LONDON PARIS

13—Cycle Controller



Time measurement and pilot valve operation are handled by separate mechanisms in a new multiple-cam time cycle controller, the Model C500 Impulse-Sequence Cycle Controller. Design is said to give accurate timing, high speed and torque for pilot valve operation, and flexibility of application. Timing is by a Telechron-driven aluminum disc with a 25-inch time scale. Scheduled operations are incorporated by cutting notches in time scale. Cams are individually adjustable and do not require fine adjustment for accurate results. All instruments are drilled for eight cams and pilot valves. The Bristol Co.

14—Pressure Valve



The hazardous possibility of an individual's backing the spindle out of a valve in service on a cylinder or line containing gas at high pressure is said to be eliminated in the Underwriters' approved "SE-CO" packless stem valve. A brass retaining washer, held in place by a Waldes snap ring, stops upward motion of the spindle in the wide-open position. The retaining washer is free to rotate, preventing the spindle from becoming wedged in open position. "Freezing" in the closed position is avoided by Neoprene seat. Equipped with Neoprene "O" rings as well as the seat, valve has a forged brass body and full-grip handwheel. Weight, 1.35 lbs.; height, 4½ in. open, 4¼ in. closed. Approved operating pressures, 1 oz. to 3500 psi.; temperatures 70 to 250° F.; maximum open and closed torque, 35 in. lbs. Security Valve Co.

15—Mechanical Packing

"Petro-pak" No. 1675, made from a special rayon roving, and developed mainly for mechanical packing, is said to be ideal for tight-sealing service on refinery and field equipment handling oils, gasolines, and other volatiles at normal atmospheric temperatures. It is saturated with a special lubricant that will not dissolve or wash out from the effects of petroleum and its solvents. It is available in rolls, in sizes from ¼ to 1 in., inclusive, in units of 1/16 in. Quaker Rubber Corp.

16—Pneumatic Control

Featuring faster action, greater flexibility, and increased compactness than previous L&N models, the Model R Speedomax Pneumatic Controller handles process upsets, returning temperature or other condition to the control point quickly. For temperature, pH, gas analysis, and electrolytic conductivity. Available with round or strip chart. Simple proportioning or complete control with automatic reset and rate action. Leeds & Northrup Co.

Trade Literature

17—Electron Microscope

Philips Technical Review, Vol. 9, No. 2; contains an article on a new electron microscope with continuously variable magnification now in use at the Institute of Electron Microscopy at Delft, Holland, in which resolving power amounts to about 25 Angstroms. Magnification can be varied from 1000 to 80,000. North American Philips Co., Inc.

18—Slide Rules

How to Choose a Slide Rule, by Don Herold, is an amusing and educational booklet on the history of the instrument and how to select the proper style for the job. Illustrated with cartoons by the author. Keufel & Esser Co.

19—Instruments

Instrumentation, July-August, 1947, Vol. 2, No. 6, contains sections on technology, applications, and maintenance of instruments of interest to refiners. The 32-page booklet is illustrated with photographs and drawings. Brown Instrument Co.

20—Cold Insulation

Holding Low Temperatures with Better Insulation, a 20-page manual with technical information for users of mineral wool insulation, including charts for calculation of proper thicknesses of various kinds of insulation, and a brief description of an application of mineral wool to a butane storage problem. Industrial Mineral Wool Institute.

21—Simple Business System

The Simplest Business System, a 20-page booklet describing a new process for rapid reproduction of typewritten letters, forms, charts, drawings, photographs, and the like. Letters can be duplicated at less than 1½c per copy in 25 seconds, it is claimed. Ozalid, Division of General Aniline & Film Corp.

22—Steel Plate Shapes

Steel Plate Shapes; 12-page booklet describing carbon and alloy steel plate shapes 3/16 in. thick and heavier, up to 195 in. wide. Shapes can be flame-cut up to 30 in. thick. Shearing facilities up to 1¼ in. thick without dies. Bending up to 8 in. thick. Also blanking and pressing. By-Products Steel Corp., Div. Lukens Steel Co.

23—Expansion Joints

CMH Free-Flexing and Controlled Bellows-Type Expansion Joints, Bulletin EJ-47, describes expansion joints for pipe lines having pressures up to 300 psi. and temperatures to 900° F. Sizes range from 4 to 24 in. inside diameters, with single and multiple-corrugations in copper or stainless steel. Chicago Metal Hose Corp.

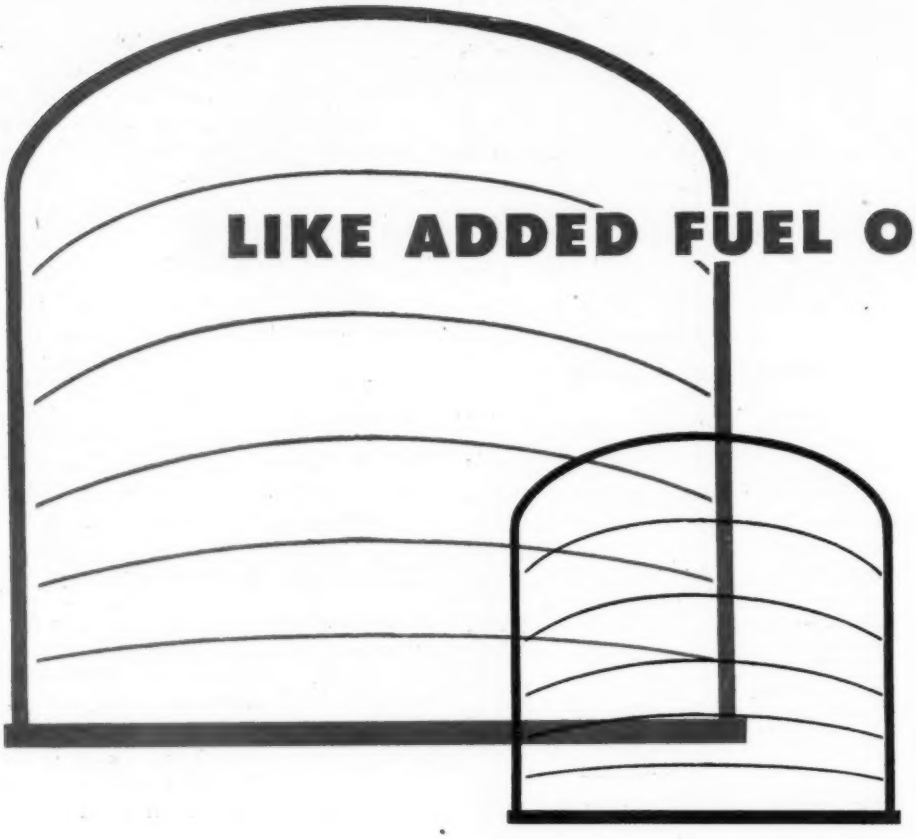
24—Gaskets

Melrath Gaskets, Catalog No. 47, a 64-page catalog giving the latest information about this company's gaskets and gasket materials. Includes specifications, sizes, engineering data, a simplified selector chart, and prices. Melrath Supply & Gasket Co.

More "What's New!" Items on Page 711

DU PONT FUEL OIL STABILIZER No. 1

LIKE ADDED FUEL OIL CAPACITY



Bringing cracked stocks up to a satisfactory level of stability is just like adding extra fuel oil capacity.

And that is just what Du Pont Fuel Oil Stabilizer No. 1 does in many fuels. Added to fuel oils immediately after distillation it improves storage stability to the extent that less stable stocks can be used satisfactorily. Maximum production can be obtained at time of maximum demand by inclusion of thermal stocks in finished blends. Inventories can be built up during ordinarily slack seasons.

Write, now, for sample for laboratory evaluation. Actual storage tests, rather than accelerated tests, will provide the most reliable evidence of its effectiveness. *E. I. du Pont de Nemours & Co. (Inc.), Petroleum Chemicals Division, Wilmington 98, Delaware.*

CONSULT DU PONT: *Du Pont technical men with many years of practical experience in the laboratory and in the field, will work with you in selecting or developing the right additives to meet your specific needs.*

DU PONT
REG. U. S. PAT. OFF.

PETROLEUM CHEMICALS

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

What's New!

25—Resistance Standards

Resistance Standards and Resistance Bridges, bulletin No. 100, presents operation, application, construction, and other pertinent data on Wheatstone, Kelvin, Mueller, and Limit Bridges, as well as on Standard Resistors of the Bureau of Standards and Reichanstalt types. Rubicon Co.

26—Automatic Controls

Automatic Equipment for Pressure and Level Control, Catalog 47, over 100 pages on the Kontrol Motor line of equipment. Contains five sections covering diaphragm valves, liquid level controllers, strainers, pressure reducing and regulating valves, pump governors, and steam plant equipment. Kieley & Mueller, Inc.

27—Bolts and Fasteners

Pawtucket, Catalog No. 46, a new bulletin providing specifications and price listings on a line of brass, bronze, silicon bronze, stainless steel, and monel metal bolts, nuts, washers, and screws. Pawtucket Mfg. Co.

28—Small Boilers

Type H Stirling Boiler, a new bulletin describing a relatively small water-tube unit, designed primarily for installation where headroom is limited, and adapted to the modernization of smaller power plants. The boiler can be built for any fuel or method of firing and may be set singly or in battery. Babcock & Wilcox Co.

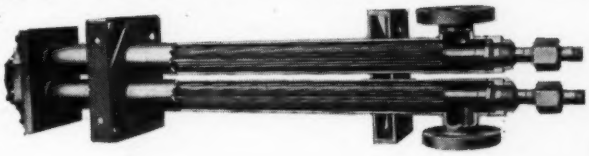
29—Deaerators

Cochrane Atomizing Deaerators, Publication 4160, a revised edition of the 20-page booklet describing a type of deaerator originally developed for marine service but now finding application in a broad field of hot process water softening processes. Cochrane Corp.

For Your Convenience

Business reply cards are included in this issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing page 705. Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the bottom of the card, and drop it in the mail. No postage required.

Why G-FIN is widely adaptable to many kinds of SERVICES • FLUIDS • UNITS



The G-FIN Element, originated 15 years ago by Griscom-Russell, has demonstrated the greatest range of usefulness of any heat transfer surface on the market.

These elements are used in more than 40,000 Twin G-Fin Sections serving as heaters, coolers, condensers and heat exchangers for a wide variety of liquids, vapors and gases. They are also extensively used in tank heaters, contactor bundles, and baffled units.

One reason for this unequalled adaptability of the G-Fin element is its longitudinal fins which provide six to eight times the external heat transfer surface of a bare tube. Another reason is that these elements can be applied to standard interchangeable sections which can be used for many different services. G-Fin elements have fully proven their dependability over long periods of service and under severe operating conditions.

THE GRISCOM-RUSSELL CO.,
285 Madison Avenue, New York 17, N. Y.

GRISCOM-RUSSELL
Pioneers in Heat Transfer Apparatus

NEW, IMPROVED CHEMICAL MANUFACTURING PROCESSES HAVE BEEN MADE POSSIBLE WITH

Tabletted & Extruded *Catalysts*

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PREFORMED CATALYSTS

are manufactured by

DIAMOND-HARSHAW CO.

HARSHAW

THE **HARSHAW CHEMICAL** CO.

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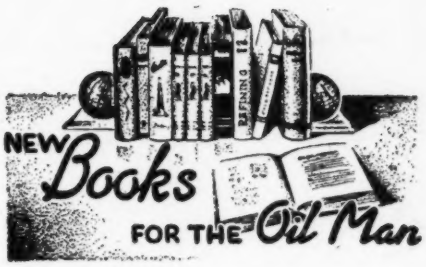
Exclusive Sales Agents for

DIAMOND-HARSHAW COMPANY

The petroleum, rubber, plastic, and pharmaceutical industries are making great strides in the use of catalysts for the production of many important synthetic organic chemicals.

The preformed catalysts supplied by Harshaw in a variety of sizes are used in such reactions as alkylation, oxidation, isomerization, dehydrogenation, hydroforming, hydrogenation, polymerization, dehydration, and desulphurization.

If you have a catalyst problem, perhaps our experience in this field may prove helpful. Feel free to discuss it with us.



Copies of all books reviewed here may be ordered from the Reader's Service Department, Petroleum Processing, 1213 West Third St., Cleveland 13, for the prices listed, postpaid, unless indicated otherwise. Ohio purchasers please add 3% tax.

Faraday Encyclopedia, Vol. II Covers C_6 and C_7 Compounds

Encyclopedia of Hydrocarbon Compounds, Vol. II, C_6 and C_7, compiled by Joseph E. Faraday, 6¾ x 9 in., 603 pages, loose-leaf binding in stiff cloth cover, $17.50.

This latest volume of the *Encyclopedia of Hydrocarbon Compounds* gives data on the C_6 and C_7 compounds, and supplements the first volume, which covered the C_1-C_5 group.

As in the first volume (*NPN Technical Section*, June 5, 1946, p. R-477) all known compounds in the C_6-C_7 groups are arranged according to the formula index system of Richter. For each of them, where the data is available, the following information is given: molecular and structural formulas, names of the compound, occurrence, every known method of preparation and references to each one, and outstanding properties.

A new feature of the encyclopedia is the Faraday number applied to each compound, a group of three figures calculated on the state of unsaturation of the compound and on substituent chains. It is designed to make it easier to find a desired compound in the listing of a group of compounds with the same molecular formula.

The same type of loose-leaf binding is used for this new volume as was employed for Vol. I. This method of binding has been adopted to permit the easy inclusion of additional and corrected information when issued by the publisher in the form of replacement sheets.

The completeness of the material presented, the pains which apparently have been taken to make it as accurate as possible, and the provisions for keeping it up-to-date with periodic revisions all indicate that the Encyclopedia will be the standard English-language reference text on Organic Chemistry.

Dr. Faraday is Research Chemist with Calico Printers' Association, Ltd.

1947 Priestley Talks on Fuel Now Available in Book Form

Physical Chemistry and the Technology of Fuels, by A. W. Gauger, 8½ x 11 in., 114 pages, paper binding, $2.00.

The 21st Annual Priestley Lectures on the *Physical Chemistry and Technology of Fuels* is described by the author as a review of the present state of our knowledge about fuels with particular emphasis on those aspects that are of interest to physical chemists.

While it deals primarily with coal the book gets into the interconversion of solid, liquid, and gaseous fuels, gasification of solid and liquid fuels, fuels as chemical raw materials, and the nuclear energy power plant.

Dr. Alfred W. Gauger, professor of fuel technology and director of the Mineral Industries Experimental Station at the Pennsylvania State College, delivered the Priestley Lectures at State College, Penna., April 21-25, 1947

He joined the college in 1931 and organized the curriculum in fuel technology as well as the research program of the Mineral Industries. This printed copy of his lectures may be obtained direct from Ray Dickison, Dept. of Chemistry, Pennsylvania State College, State College, Penn.

ASTM Issues 1946 Index on Standard Specifications

Index to A. S. T. M. Standards, Dec., 1946, 5⅞ x 8⅝ in., 234 pages, heavy paper binding.

The December, 1946, issue of the *Index to ASTM Standards* was issued by the American Society for Testing Materials in June, 1947, and is to be considered an adjunct to the ASTM 1946 *Book of Standards*. It enables any of the approximately 1400 standard specifications and tests in the volumes to be readily located. It is of service to those who would like to determine whether ASTM has issued standard specifications, test methods, or definitions covering any particular engineering material or subject.

All items are listed in the Index under appropriate key-words according to the particular subjects they cover. As a convenience, a list is given of the specifications and tests in numerical sequence of their serial designations.

Copies of the publication are furnished without charge or written request to the Society headquarters, 1916 Race Street, Philadelphia 3, Penna.

1946 Forum of Committee D-2 On Diesel Fuel Oils Published

Forum on Diesel Fuel Oils, 6 x 9 in., 38 pages, heavy paper binding, illustrated, $1.00.

Forum on Diesel Fuel Oils includes eight non-technical papers discussing Diesel fuel problems and conclusions of leaders representing consumers and producers of the fuel and manufacturers of Diesel equipment. The papers were presented in a forum held November 13, 1946, in Chicago, and sponsored by Technical Committee F of ASTM Committee D-2 on Petroleum Products and Lubricants.

Subject matter covered includes postwar military trends, railroad Diesel uses, bus transportation, burner distillate fuels, and east and west coast distillate production. Among oil industry speakers represented were John C. Day, secretary of the Western Petroleum Refiners Association; Joseph E. Keller, attorney for National Petroleum Association; and A. G. Marshall, consultant for Shell Oil Co., Inc.

Use of Statistics Explained For Engineers in New Book

Examination of Industrial Measurements, by John W. Dudley, Jr., 5½ x 8½ in., 113 pages, stiff cloth binding, indexed, $2.00, (1946).

Engineers in general have one fault—they lack the ability to express themselves clearly in writing, and to prepare reports that get their ideas and thoughts across to a layman unfamiliar with technical subjects.

Although *Examination of Industrial Measurements* wasn't written to overcome this deficiency, it may help—it discusses statistics and how they can be used by the engineer. The book, which is relatively brief (only slightly over 100 pages), attempts to acquaint the engineer with some useful, simple, and adaptable statistical tools which can help him collect data in such a manner that they can be subjected to more elabate analyses when necessary.

Among other subjects, the book covers methods of presenting data, normal probability curves, quality control curves, modified median-normal curves, and correlation and curve fitting. The author, J. W. Dudley, Jr., is a chemical engineer with American Viscose Corp.

Third Edition in Weld Lessons Represents Complete Revision

Lessons in Arc Welding, Third Edition, published by Lincoln Electric Co., 5½ x 8½ in., 158 pages, semi-flexible simulated leather binding, illustrated, 50c.

The third edition of *Lessons in Arc Welding* represents a thorough revision of the previous editions. An added feature is the questions and answers section in the last part of the book. The questions and answers are separate, making it easy to use the section for quizzes or self-examination.

The new edition incorporates considerable new information on AC as well as DC welding methods, new procedures covering large electrodes, and a number of lessons on pipe welding which should be of value to refinery maintenance departments. Included is a discussion of the problem of distortion with recommendations regarding its prevention and control.

Emulsions Formulary Indicates Increased Growth in the Field

Practical Emulsions, 2nd Edition, by H. Bennett, 5⅜ x 8½ in., 568 pages, stiff cloth binding, indexed, $8.50.

Although animal and vegetable as well as mineral oils are used in emulsions, a large part of the Industry is a source of use for petroleum hydrocarbons. *Practical Emulsions* is not written from a theoretical standpoint; it deals primarily with the manufacture and evaluation of emulsions for industrial use and selling.

Petroleum products go into many types of emulsions—cutting oils, asphalt emulsions, dispersing and wetting agents, agricultural sprays, leather treatment agents, certain waxes, and medicinals.

The second and revised edition of his volume contains additional data on partial fatty acid esters of polyhydric alcohols, and their application in food products; special section on germicides; and a symposium on industrial emulsions. All the most recently developed formulas have been added to the section on formulas. Included is a list of some 600 emulsifying agents. The list of emulsions covers some 960 references.

Author Bennett is well known for his *Chemical Formulary, Chemical and Technical Dictionary* and *Commercial Waxes*. He is Technical Director of Glyco Products Co., Inc.

Weathering Effects on Stainless Covered in ASTM Symposium

Symposium on Atmospheric Weathering of Corrosion-Resistant Steels, 6 x 9 in., 92 pages, heavy paper cover, illustrated, $1.50.

An up-to-date picture, based on the latest data, of the behavior of the stainless steels when exposed to atmosphere is presented in this collection of seven technical papers delivered during the symposium sponsored by ASTM Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel, and Related Alloys, and held at the 1946 ASTM meeting in Buffalo.

It incorporates a great amount of information and data that have been developed not only under the auspices of Committee A-10, but by leading organizations concerned with the problem.

Most of the exposure tests described were conducted in the eastern section of the U. S., and along the Atlantic Coast, ranging from New York City south to Florida.

Second in Organic Analytical Reagent Series off the Press

Organic Analytical Reagents, Vol. II, by Frank J. Welcher, 6 x 9 in., 530 pages, stiff cloth binding, indexed, $8.00 individual volume, $7.00 in the series.

Organic reagents are employed in various ways to facilitate the detection and determination of chemical substances. At present, they are said to be gaining in popularity because of their greater sensitivity and specificity, as compared with inorganic reagents.

The material in organic *Analytical Reagents* is arranged entirely according to the regagents concerned, with the reagents themeslves being grouped by general type. Under each one, the author gives data regarding it, including chemical and structural formulas, Beilstein reference, physical properties and analytical uses. He then describes the known procedures for the preparation of the reagent, and both qualitative and quantitative determinations of various substances.

Vol. I (reviewed in PETROLEUM PROCESSING, July, 1947) covered hydrocarbons, substitution products of hydrocarbons, alchohols, phenols, miscellaneous phenolic compounds, amino phenols, phenolsulfonic acids, 8-hydroxyquinoline and its derivatives azo derivatives of 8-hydroxyquinoline, ethers, aldehydes, and ketones.

Vol. II covers organic acids, halogen substituted acids, hydroxy acids, amino acids, miscellaneous acids, acyl halides, acid anhydrides, esters, amines, and quaternary ammonium compunds.

Indices are arranged according to both reagents (including synonyms) and substances for which they can be used in analytical procedures.

Dr. Welcher, the author, is identified as associate professor of chemistry in the Extension Division, Indiana University. The complete series covers four volumes. Volumes III and IV are expected to be available in September and November, respectively.

NEMA Issues Second Revision on Motor and Generator Standards

Motor and Generator Standards, Publication No. 45-102, Revision No. 2, 7¾ x 10½ in., set of 74 loose sheets.

This second revision in the Approved Standards for Motors and Generators, Publication No. 45-102 of the National Electrical Manufacturers Association includes a number of new standards in addition to revisions.

New standards cover motors for belted fans and blowers, stokers, sump pumps, gasoline dispensing pumps, and oil burners.

Note: NEMA Standards and further information may be obtained by writing direct to the Association, at 155 East 44th St., New York 17, N. Y.

CORRECTION

Our attention has been called by M. M. White, assistant chief chemist for Willys-Overland Motors, Inc., Toledo, to a minor error in the article "Infrared Analyses of Alkylates", published in PETROLEUM PROCESSING for May, 1947, pp. 356-363. The error occurs in the sample calculations on pp. 362 and 363, as given below (the points in question are printed in bold face):

As Published	As Corrected
$D_1 = 1000 \log 1/.465 = 332$	$D_1 = 1000 \log 1/.465 = 332$
$D_2 = 1000 \log 1/.410 = 388$	$D_2 = 1000 \log 1/.410 = 388$
$D_3 = 1000 \log 1/.165 = \mathbf{779}$	$D_3 = 1000 \log 1/.165 = \mathbf{783}$
$332 = 705x + 85y + 85z$	$332 = 705x + 85y + 85z$
$388 = 55x + 1620y + 60z$	$388 = 55x + 1620y + 60z$
$\mathbf{779} = 125x + 25y + 1610z$	$\mathbf{783} = 125x + 25y + 1610z$
$x = (332 - 85y - 85z)/705$	$x = (332 - 85y - 85z)/705$
$y = (388 - 55x - 60z)/1620$	$y = (388 - 55x - 60z)/1620$
$z = (\mathbf{779} - 125x - 25y)/1610$	$z = (\mathbf{783} - 125x - 25y)/1610$
$x = 332/705 = 47\%$	$x = 332/705 = 47\%$
$y = [388 - (55 \times 47\%)]/1620$	$y = [388 - (55 \times 47\%)]/1620$
$= (388 - \mathbf{22})/1620 = 22\%$	$= (388 - \mathbf{26})/1620 = 22\%$
$z = [\mathbf{799} - (125 \times 47\%) - (25 \times 22\%)]/1610$	$z = [\mathbf{783} - (125 \times 47\%) - (25 \times 22\%)]/1610$
$= (\mathbf{799} - 59 - 5)/1610 = 44\%$	$= (\mathbf{783} - 59 - 5)/1610 = 44\%$
$x = [332 - (85 \times 22\%) - (85 \times 44\%)]/705$	$x = [332 - (85 \times 22\%) - (85 \times 44\%)]/705$
$= (332 - 19 - 37)/705 = 39\%$	$= (332 - 19 - 37)/705 = 39\%$
$y = [388 - (55 \times 39\%) - (60 \times 44\%)]/1620$	$y = [388 - (55 \times 39\%) - (60 \times 44\%)]/1620$
$= (388 - 22 - 36)/1620 = 21\%$	$= (388 - 22 - 36)/1620 = 21\%$
$z = [\mathbf{779} - (125 \times 39\%) - (25 \times 21\%)]/1610$	$z = [\mathbf{783} - (125 \times 39\%) - (25 \times 21\%)]/1610$
$= (\mathbf{799} - 49 - 5)/1610 = 45\%$	

As indicated above, the correct value of D_3 is 783 instead of the previously published value of 779, which correspondingly changes the balance of the calculations. It should be noted, however, that this error does not alter the values of x, y and z.

Another BECKMAN pH Advancement!

THE BECKMAN MODEL H PORTABLE AC pH METER

Some Important Features of The Beckman Model H

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Full Temperature Compensation, 0 to 100° C: A built-in temperature compensator covering the full range of 0° to 100° C can be set to compensate automatically the effect of temperature changes on the EMF of the glass electrode over the entire pH range of the instrument. Thus, the pH at the electrode temperature may be read directly from the dial without calculation or corrections.

Direct Millivolt Scale: The Model H Meter is graduated in millivolts as well as pH units, and a range switch permits measuring directly either in millivolts or pH at will.

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NO LONGER need you sacrifice accuracy and dependability to get the convenience of AC operation in a portable pH Meter. For now the same organization that pioneered modern glass electrode pH equipment, and has pioneered every major advancement in modern pH instrumentation and methods, brings another important development... a portable pH Meter that operates from standard AC current *without sacrificing any of the accuracy and dependability that are so essential in modern pH applications.*

This new instrument – the Beckman Model H pH Meter – has been in development over a long period of time. Many different designs and circuits were tested and rejected before an instrument was perfected that meets the rigid Beckman standards of excellence. The Model H Meter is not just an "AC" pH Meter. It is an instrument embodying advancements in circuit design that insure the same high operating efficiency and accuracy that have made Beckman pH Equipment standard throughout the world.

A few of the many unique features incorporated into the Beckman Model H pH Meter are outlined at right. Contact your nearest distributor of Beckman pH Instruments for further details... or write direct. *Beckman Instruments,* National Technical Laboratories, South Pasadena 23, Calif.

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"INDUSTRIAL WASTE DISPOSAL

for

Petroleum Refineries and Allied Plants"

Disposing of industrial wastes is a never-ending problem—yet there has been a surprising lack of up-to-date information and authoritative reference data on this important subject.

For that reason, "INDUSTRIAL WASTE DISPOSAL" is a book that fills a real need and will be welcomed by all engineers and technicians who are concerned with effective, economical control and disposal of harmful wastes.

The author—W. B. Hart—is a widely recognized and highly respected authority in this field, having been actively engaged in solving the problems of industrial waste disposal for the past 20 years; with Atlantic Refining Company since 1923, he has charge of waste disposal for his Company; a graduate of the University of Pennsylvania with the degree of Doctor of Pharmacy, Mr. Hart was instrumental in the design of the approved API oil-water separator, and is Chairman of the API Committee on Disposal of Refinery Wastes.

"INDUSTRIAL WASTE DISPOSAL" is a complete treatise, covering the three important phases of the industrial waste problem: the essential background of overall industry-government-public interests; the kinds of industrial waste and their harmful effects; and the "how" of their proper disposal.

Besides being an 'on-the-desk' ready reference for every refinery man who works directly on waste disposal problems, "INDUSTRIAL WASTE DISPOSAL" is a useful addition to the General Library of refineries and other industrial plants that have to contend with harmful wastes.

Early chapters of "INDUSTRIAL WASTE DISPOSAL" deal with the economic and legislative aspects of industrial wastes—from the viewpoint of Industry, of Government, and of the Public; then follows a thorough discussion of the fundamental principles of industrial waste control, including the Kinds of wastes and their Effects on water and plant life—whether they be wastes from a petroleum refinery, a dairy, a tannery or some other type of industrial plant.

The chapters on the Investigation of Waste Problems also have a broad application to general industry; the concluding chapters—Treatment of Oil-containing Wastes—are directly concerned with refinery waste disposal.

Methods for determining, measuring and controlling wastes are covered in a thorough and practical manner, with appropriate sketches and diagrams.

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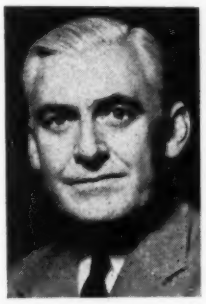
PERSONALS

Petroleum Technologists in the Headlines

Mr. Murphree



Mr. Russell

E. V. Murphree, executive vice president, was elected president of Standard Oil Development Co., to succeed **Robert P. Russell,** who resigned to become technical consultant to International Basic Economy Corp., New York. A native of New Jersey, Mr. Murphree graduated from the University of Kentucky and was a staff assistant at Massachusetts Institute of Technology.

He joined New Jersey Standard in 1930 as director of a new technical group developing chemical processes for petroleum refining. He became director of research and development at Esso laboratories at Baton Rouge and in 1934 was made vice president of the Hydro Engineering & Chemical Co., a Jersey Standard affiliate in New York. He became manager of research and development for Standard Oil Development Co. in 1936, vice president in 1938 and executive vice president in 1946.

Mr. Russell was at one time head of Esso Laboratories in Baton Rouge, joining the Development company in 1927. He became vice president of S.O.D. in 1934 and president in 1944.

° ° °

Carey R. Wagner, consultant in the petroleum and chemical fields and secretary of the Petroleum Division of the American Chemical Society, has been made vice president of General Aniline & Film Corp. in charge of development and research. He will direct the coordination of the company's research activities in dyestuffs, photography, detergents, resins and Ozalid sensitized materials, as well as fundamental research in related fields.

Dr. Wagner

A native of Ohio, Dr. Wagner graduated from Wooster College in 1915, was a graduate assistant in chemistry at Purdue for a brief period and thereafter returned to Wooster for a time as Professor of Chemistry. The college awarded him an honorary degree of Doctor of Science in 1945.

He was for many years research director for Pure Oil Co., leaving in 1942 to become a consultant.

° ° °

Whitney Weinrich has joined the staff of the Houdry Laboratories as head of pilot plant development.

After receiving an M.S. degree from Massachusetts Institute of Technology he returned to his native Hawaii for a year's experience in the sugar industry. In 1933 his interest in petroleum brought him back to the mainland and to Gulf Corp.'s Philadelphia Refinery as a petroleum technologist. A year and a half later he became a Gulf Research Industrial Fellow at the Mellon Institute. In 1935 he returned to Gulf Research at its laboratories in Pittsburgh.

Mr. Weinrich

During the war he was in PWS's refining division. Upon leaving Washington after the war, Mr. Weinrich joined Phillips Petroleum Co. as manager of the Bartlesville Pilot Plant Section of the chemical engineering department. From these he joined the teaching staff of Towne Scientific School, University of Pennsylvania.

° ° °

Victor G. Meadors has left the synthetic rubber division of the U. S. Rubber Co. to become senior research chemist with the Carter Oil Co. in Tulsa.

° ° °

B. B. Klima has been transferred from the Ethyl Corp. research laboratories in Detroit to the development laboratories of the company's Ethyl manufacturing plant in Baton Rouge, La.

° ! °

R. J. Kenard has been transferred from the technological department of the Shell Oil Co. refinery at Deer Park, Houston, to the research and development department at Shell's main offices in New York City.

° ° °

Victor Denslow, junior chemical engineer for Atlantic Refining Co., Philadelphia, has been promoted to assistant chemical engineer in the research and development department.

° ° °

C. C. Book has joined Republic National Gas Co. as corrosion engineer with temporary headquarters in Corpus Christi. He was formerly lubrication engineer with MacMillan Petroleum Corp. in New Orleans and petroleum engineer with Root Petroleum Co., El Dorado, Ark.

° ° °

Additions to the staff of the research department of Standard Oil Co. (Ind.) at Chicago are **A. C. Coggshall** and **K. S. Kuntson,** chemical engineers. **A. B. Brown** has been appointed senior research associate, **J. A. Bolt** assistant superintendent of technical service, **N. E. Lemmon** research associate and **D. W. Bransky, D. E. Bruce, T. B. Tom, L. M. Hobbs** and **C. W. Peters** group leaders. Mr. Peters replaces **J. E. Swearingen** who was transferred to Tulsa.

° ° °

J. M. Wilson, formerly manager of the products application department at Shell Oil Co.'s Wood River, Ill., refinery has been promoted to assistant superintendent in charge of lubricants. He will succeed **M. A. Rogers,** who has been transferred to the Houston refinery.

° ° °

Dr Luigi G. Castelli has been named South American representative for the Houdry Process Corp.

Dr. Castelli began his studies at the University of Naples where he received his engineering degree. He continued at the Sorbonne University, Paris, and finished postgraduate work at the Institute of Physics and Chemistry.

Dr. Castelli

The new Houdry representative, whose headquarters are in Buenos Aires, has had extensive experience in the petroleum and industrial fields. He has been associated with the engineering department of the Public Service Corp. of New Jersey; he has served as consulting engineer in charge of foreign business for Seabrook Engineering Corp.; and has been general Latin-American representative for the Lummus Co.

° ° °

Henry L. Smithers, Jr., an assistant mechanical engineer at Standard of New Jersey's Bayway Refinery has been promoted to the position of assistant regional engineer in the Mechanical Department.

He was graduated from Cornell University and entered the military service shortly after graduation. He started in 1945, as a junior engineering inspector in the Safety Department and was named assistant mechanical engineer in 1946.

R. N. Giles, superintendent of technical service in the Whiting, Ind., laboratories of Sandard Oil Co. (Ind.), has been promoted to director of technical service with headquarters in the research department at the general office in Chicago. He will be responsible for direction of technical service activities at all of the Standard of Indiana refineries. Dr. Giles joined Standard Oil in 1930 after graduate work at Ohio State University.

Dr. Giles

Dr. Harte

Mr. Meehan

C. R. Harte, assistant superintendent of technical service at Whiting, succeeds Dr. Giles. Dr. Harte joined the company in 1936, after graduate work at the University of Michigan and several years of subsequent experience in industry.

W. F. Meehan, a group leader, was advanced to fill the post vacated by Dr. Harte. Mr. Meehan became associated with Standard in 1942 following graduation from the University of Detroit. **R. S. McDaniel** succeeds Mr. Meehan.

E. B. Tucker has been appointed section leader in charge of a newly organized research analytical section of the Whiting laboratories. **H. M. Grubb** and **W. L. Rittschof** have been made group leaders in this section. **F. W. Porsche** has been made foreman of the gas analysis laboratories, succeeding Mr. Rittschof.

G. W. Flint has been advanced to section leader in charge of work on specialties. **C. E. Adams** has been appointed section leader in charge of exploratory research on chemical products. **E. J. Campau, A. W. Lindert, D. E. Burney, Philip Hill, W. R. Hertwig,** and **Moses Gordon** have been made group leaders. **Michael Dufinecz** is appointed patent advisor assisting **J. C. Stauffer.**

* * *

W. D. McElroy has been named manager of the Research and Development Division of the Pittsburgh Consolidation Coal Co. at Liberty, Pa. He will be in charge of all pilot plant operations in the company's coal gasification program.

He received his B.S. in chemical engineering from the University of West Virginia in 1927 and a master's degree in physics in 1928. He has been associated with the United Gas Improvement Co., Philadelphia, where he spent 12 years in its research and development department.

* * *

W. Nelson Axe has recently been appointed supervisor of the lubricating oil research section for Phillips Petroleum Co. He received his Ph. D. degree from the University of Texas and joined Phillips eight years ago. Prior to his assuming his new position Dr. Axe was in charge of patent work in Phillips research department.

Spencer S. Prentiss was named associate director in charge of patent affairs for the research department of Phillips. Before joining the company he was associated with government patent work for the Office of Scientific Research and Development in Washington.

* * *

William M. Kellner has been named to fill the vacancy as night refinery superintendent caused by the retirement of **James O'Neil** at the Bayonne Refinery of the Tide Water Associated Oil Co.

Mr. Kellner's continuous service with Tide Water began in 1916 when he started in the Filter plant. He was transferred to the Press plant and advanced to the position of engineer. In 1945 he became shift foreman of the Process department, the position he held till his recent promotion to night superintendent.

Bernard E. Woods has been named to succeed Mr. Kellner as shift foreman in the Process department. He has been with the company since 1921.

* * *

Cearey D. Miller, who recently joined the Fuels Technology Division of the Battelle Memorial Institute, Columbus, Ohio, will be awarded the 1946 Manly Memorial Medal at the SAE Aeronautic (Autumn) meeting on Oct. 3 in Los Angeles.

An engineer with the National Advisory Committee for Aeronautics for the past 11 years, Mr. Miller won the distinction for his paper "The Roles of Detonation Waves and Autoignition in Spark-Ignition Engines Knock as Shown by Photographs Taken at 40,000 and 200,000 Frames per Second", presented at the SAE 1946 Summer meeting and repeated before seven SAE sections.

* * *

M. A. Bestougett, consulting engineer of the Cie. Francaise de Raffinage, Paris, and a specialist in petroleum chemistry is on a three-month visit in the United States and is a guest worker at the National Bureau of Standards, Washington He expects to visit several petroleum research laboratories while in this country.

Coming Meetings

September

8-9, American Society of Mechanical Engineers, Industrial Instruments and Regulators Division, Chicago.
8-12, Instrument Society of America, 2nd National Instrument Congress and Exhibit, Stevens Hotel, Chicago.
15-17, National Butane-Propane Association, Convention, Jefferson Hotel, St. Louis.
17-18, API Lubrication Committee, Traymore Hotel, Atlantic City, N. J.
15-19, American Chemical Society, 112th National Meeting, New York.
28-Oct. 2, American Institute of Mining and Metallurgical Engineers, Petroleum Division, 2 day technical meeting in conjunction with Regional meeting, Denver, Colo.
29-Oct. 1, American Institute of Chemical Engineers, Hotel Statler, Buffalo, N. Y.

October

2-4, Society of Automotive Engineers, autumn aeronautical meeting, Biltmore Hotel, Los Angeles.
6-8, American Society of Mechanical Enginers, Petroleum Mechanical Engineering Conference, Rice Hotel, Houston.
8-10, American Institute of Mining and Metallurgical Engineers, Petroleum Division, Mayo Hotel, Tulsa.
10, California Natural Gasoline Association, Fall meeting, Ambassador Hotel, Los Angeles.
16-17, Texas Mid-Continent Oil and Gas Association, Annual convention, Gunter Hotel, San Antonio.
16-18, National Lubricating Grease Institute, 15th Annual meeting, Edgewater Beach Hotel, Chicago.
20-22, American Society of Mechanical Engineers, Fuels Division, Joint meeting Coal Division, American Institute of Mining and Metallurgical Engineers, Cincinnati, O.
21-25, Pacific Chemical Exposition, San Francisco Civic Auditorium Sponsored by the California Section of the American Chemical Society.
23-24, American Institute of Mining and Metallurgical Engineers, Petroleum Division, Elks Club, Los Angeles.

Paul V. Keyser has been named manager of the Lubricating Oil Department for Socony-Vacuum Oil Co., Inc. He succeeds **H. S. Merriman,** who becomes a member of the National Accounts Department.

* * *

Thomas P. Simpson, who joined the Socony-Vacuum Oil Co., Inc., in 1925, has been named director of the company's research and development laboratories at Paulsboro, N. J.

Mr. Simpson was former assistant director of the laboratories and succeeds **Paul V. Keyser, Jr.,** who was advanced to manager of Socony's lubricating department in New York.

In other changes at Paulsboro, **Arlie A O'Kelly** was named associate director in charge of the chemical division, **G. H. S. Snyder** became assistant director in charge of the lubricating oil division, and **Louis P. Evans** and **John W. Payne** became supervisor and associate supervisor of the process development division, respectively.

Dr. **Louis Schmerling** of the Universal Oil Products Co., Chicago, is the winner of the first Ipatieff Prize in chemistry.

The $3000 prize, honoring achievements in the study of catalysis or high pressure, was established by Dr. Vladimir N. Ipatieff, director of the Ipatieff High Pressure and Catalytic Laboratory at Northwestern University, and Mrs. Ipatieff. The award will be given every three years to a chemist under 40 years of age. Dr. Schmerling, who is 35, was cited for his contribution to the knowledge of catalytic reactions of hydrocarbons. He received his B.S. degree from the University of Wisconsin in 1932 and his Ph.D. from Northwestern University in 1935. He has been a member of the Universal Oil Products research staff since 1935.

Dr. Schmerling

* * *

Robert K. Smith has resigned from Standard Oil Development Co. to become group head in charge of lubricants research at Kendall Refining Co., Bradford, Pa.

* * *

E. L. Stovall, Magnolia Petroleum Co., chemical engineer, has been appointed the new head of the company's laboratory at Dallas. He will supervise gas measurement, testing, water and products treating, and plant process control.

* * *

Appointment of **W. H. Hales** as chief engineer of its manufacturing department was announced by Standard Oil Co. of Calif.

Mr. Hales

Hales, a 1923 Stanford University graduate, came to work for Standard in 1924 as a construction superintendent at the company's El Segundo refinery. Most of his service with the company since that time has been at El Segundo and at Standard's Richmond, Calif., refinery. He was made chief engineer of the Richmond plant in 1943.

Other manufacturing department appointments also announced include those of **W. H. Spaulding** as assistant chief engineer, and **J. O. Ciprico** as designs engineer.

Mr. Spaulding started with Standard in 1938 after taking a master's degree at Massachusetts Institute of Technology. He was departmental job engineer prior to his new appointment. Mr. Ciprico has worked in various engineering capacities for the company since 1919, following graduation from the University of California.

* * *

J. H. Bell, assistant vice president of Foster Wheeler Corp. and head of its public relations and advertising department, has been appointed sales manager of the company's newly created Dallas district office. He will be in charge of the area embracing Ark. and parts of Texas, Okla., and Miss.

* * *

James H. Boyd, until recently eastern representative in research and development for Phillips Petroleum Co., Bartlesville, Okla., has opened offices in New York city as a chemical consultant on technical and economic appraisal of chemical markets, patents and projects in petroleum hydrocarbons, chemicals and emulsion polymerization.

Dr. Boyd has been associated with the economic aspects of petrochemicals and petroleum products for the last 18 years. He was formerly with Atlantic Refining Co., Du Pont, Phillips Petroleum Co., and Hycar, a Phillips affiliate.

* * *

Matthew VanWinkle, author of the book "Aviation Gasoline Manufacture", has been appointed Associate Professor of Chemical Engineering at the University of Texas, Austin. He comes to Texas from an assistant professorship at the University of Michigan.

Mr. VanWinkle

From 1933 to 1939 he was on the technical staff of Cities Service Oil Co. at Okmugee, Okla., then acted as a petroleum consultant before joining Standard Oil Co. (Ind.). In 1941 he became assistant professor of chemical engineering at Pennsylvania State College. He joined the chemical engineering staff of the University of Michigan in 1943 and received his Master's degree there in 1945.

* * *

Mr. Pierre H. Courouleau is now affiliated with the Chemical Plants division of Blaw-Knox Construction Co. as consulting engineer specializing in activated carbon installations for the recovery of volatile solvent vapors. Prior to joining Blaw-Knox, he was director of engineering for Carbonisations et Charbons Actifs., of Paris, France, and supervised the design and erection of solvent recovery plants in England, France, Spain, Italy and North Africa.

Dr. R. E. Benson will direct the entrance of Blaw-Knox into this new solvent recovery process field.

CLASSIFIED

Petroleum Processing announces this new classified section as a regular feature for the convenience of its readers. Classified rates are shown in the accompanying box.

Classified Rates

"For Sale," "Wanted to Buy," "Help Wanted," "Business Opportunities," "Miscellaneous" classifications, set in type this size without border—20 cents a word. Minimum charge, $5.00 per insertion.

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IRON & STEEL PRODUCTS INC.
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EDITORIAL COMMENTS

WIDENING HORIZONS

A Politician Has the Final Word On Science Foundation—And Says It

IN commenting on President Truman's failure to approve the National Science Foundation Bill passed by Congress, Senator Smith of New Jersey said his action had set the cause of science in this country back ten years.

This may prove to be no exaggeration. The President's pocket veto of the measure shows a complete lack of understanding on his part of the nature of basic scientific research and of its proper direction and administration. His insistence on retaining the power to appoint the Director of the Science Foundation, if it is provided in any reenacted bill, at least implies the possibility of political influence being exerted in the Foundation's research program. This in itself will keep many good scientists from participating in the organization and setting up of the program, and thus will impede its progress.

The nature of agency which should direct the science program had been the subject of debate in Congress for two years or more. The makeup of the directing agency provided in the bill passed by Congress had the support and approval of the majority of the leading scientists of the country, as far as could be judged by public expressions.

The Science Foundation was to be an independent agency of the executive branch of the government. Its 24 members were to be selected solely on the basis of their records as leaders in scientific thought in all branches of science and in all parts of the country, to be appointed by the President and approved by the Senate. The Foundation in turn was to appoint an executive committee of 9 of its members and also to appoint a full-time Director, answerable only to the Foundation and prescribe his powers and duties.

This type of organization of the Foundation was selected in order to eliminate the possibility that the Foundation or its executive committee would be subordinate to a single director appointed by the President. No single individual, no matter how competent, could be sufficiently qualified in all fields of science and public welfare to himself arbitrarily direct such a wide research program as is contemplated in the bill. A fundamental requirement is the close cooperation between the Director and the Foundation that could come only through the selection of the director by that board.

The administrative setup for scientific research and development proposed in the Science Foundation Bill to which President Truman has objected is used successfully in industrial research. There are also examples of where large projects financed by government funds have been efficiently directed by the same method.

In our own petroleum industry, the vast wartime aviation gasoline program was worked out in the development stages, and commercial operations directed, by a group of oil company technologists as a PAW activity, but working independently of direct supervision by any government executive. That program was one of the scientific achievements of the war. An example of where scientists are handling research funds is to be found in the work of the National Advisory Committee for Aeronautics which has done an excellent job for a number of years.

The Director of the Science Foundation, if appointed by the President, would have to be more politically-wise than science-minded to successfully retain office over a period of years. True statesmanship on the part of the President would have recognized that complete cooperation of the scientists of the nation is essential to success of the science program, and would have arranged to provide the freedom from political pressure and influence that would secure their cooperation.

Professional Men Have Their Own Voice Under the Taft-Hartley Labor Act

THE new Taft-Hartley labor law should overcome one of the main objections to the former Wagner act as far as oil company chemists, engineers and other professional employees are concerned. Under the Wagner law a group of professional employees could be, and often were, swallowed up by a large bargaining unit of non-professionals in which they had little if any voice or interest, and whose views and policies were frequently contrary to those of the professional men.

Paragraph 12 of Section 2 of the Taft-Hartley act defines a "professional employee" and Section 9b preserves the rights of professional employees to decide for themselves whether they will form thir own bargaining unit or join another.

According to the law, a "professional employee" is defined as "(a) any employee engaged in work (1) predominantly intellectual and varied in character as opposed to routine mental, manual, mechanical, or physical work; (2) involving the consistent exercise of discretion and judgment in its performance; (3) of such a character that the output produced or the result accomplished cannot be standardized in relation to a given period of time; (4) requiring knowledge of an advanced type in a field of science or learning customarily acquired by a prolonged course of specialized intellectual instruction and study in an institution of higher learning or a hospital, as distinguished from a general academic education or from an apprenticeship or from training in the performance of routine mental, manual, or physical processes."

Further than that, the definition goes on to include those persons working under supervision with the aim of obtaining professional status, as follows: "(b) any employee who (1) has completed the courses of specialized intellectual instruction and study described in clause (4) or paragraph (a), and (2) is performing related work under the supervision of a professional person to qualify himself to become a professional employee as defined in paragraph (a)."

With regard to bargaining groups, the law provides that "The [National Labor Relations] Board shall decide in each case whether, in order to assure to employees the fullest freedom in exercising the rights guaranteed by this Act, the unit appropriate for the purpose of collective bargaining shall be the employer unit, craft unit, plant unit, or subdivision thereof; *Provided*, that the Board shall not (1) decide that any unit is appropriate for such purposes if such unit includes both professional employees and employees who are not professional employees unless a majority of such professional employees vote for inclusion in such unit. . . ."

From the viewpoint of the scientists, engineers and technologists, this feature of the new law goes a long way toward assisting them in achieving democracy in their employer-employee relationships.

READERS' comments and opinions will be welcomed by the editors of PETROLEUM PROCESSING, 1213 West Third Street, Cleveland 13, Ohio

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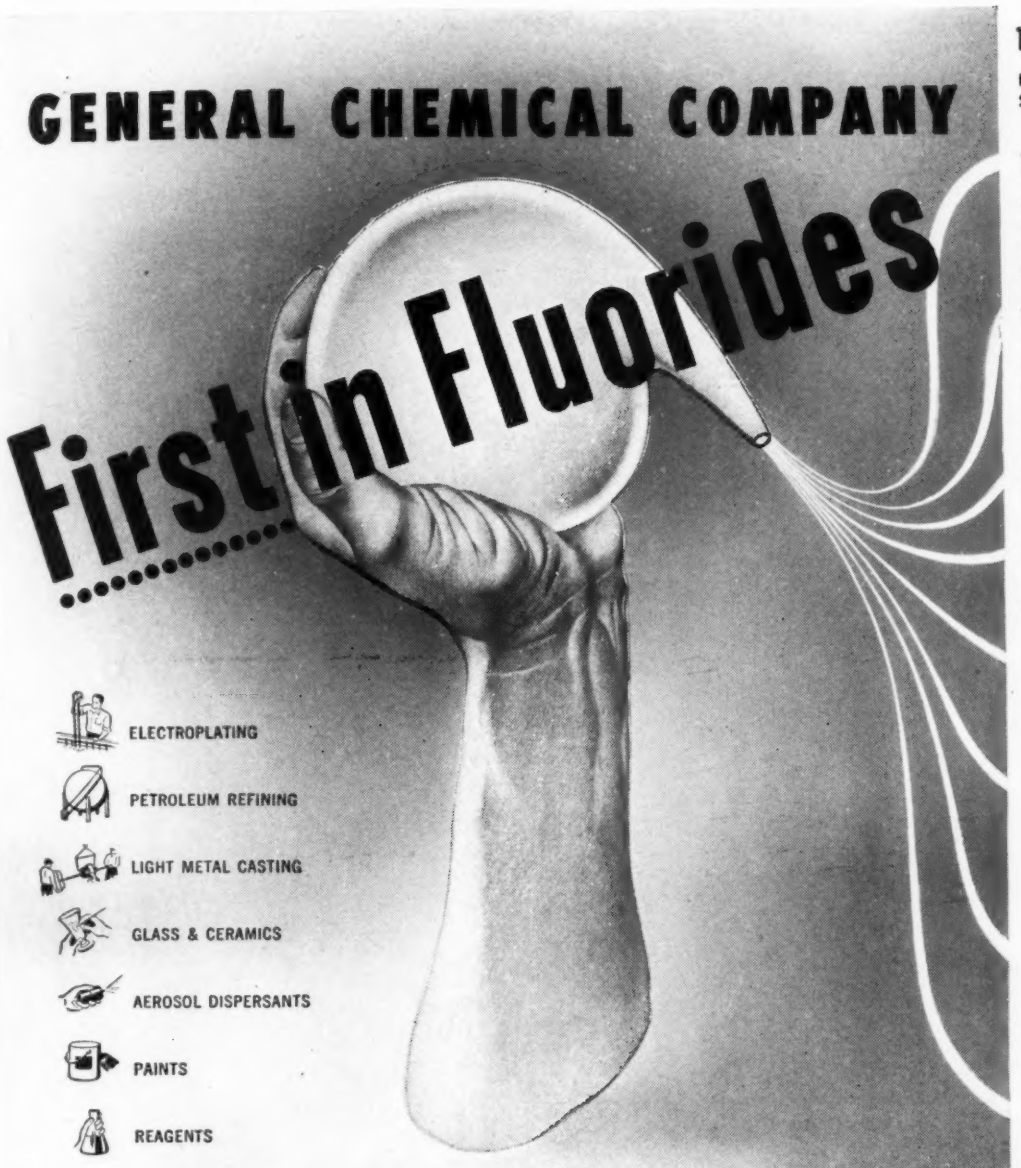

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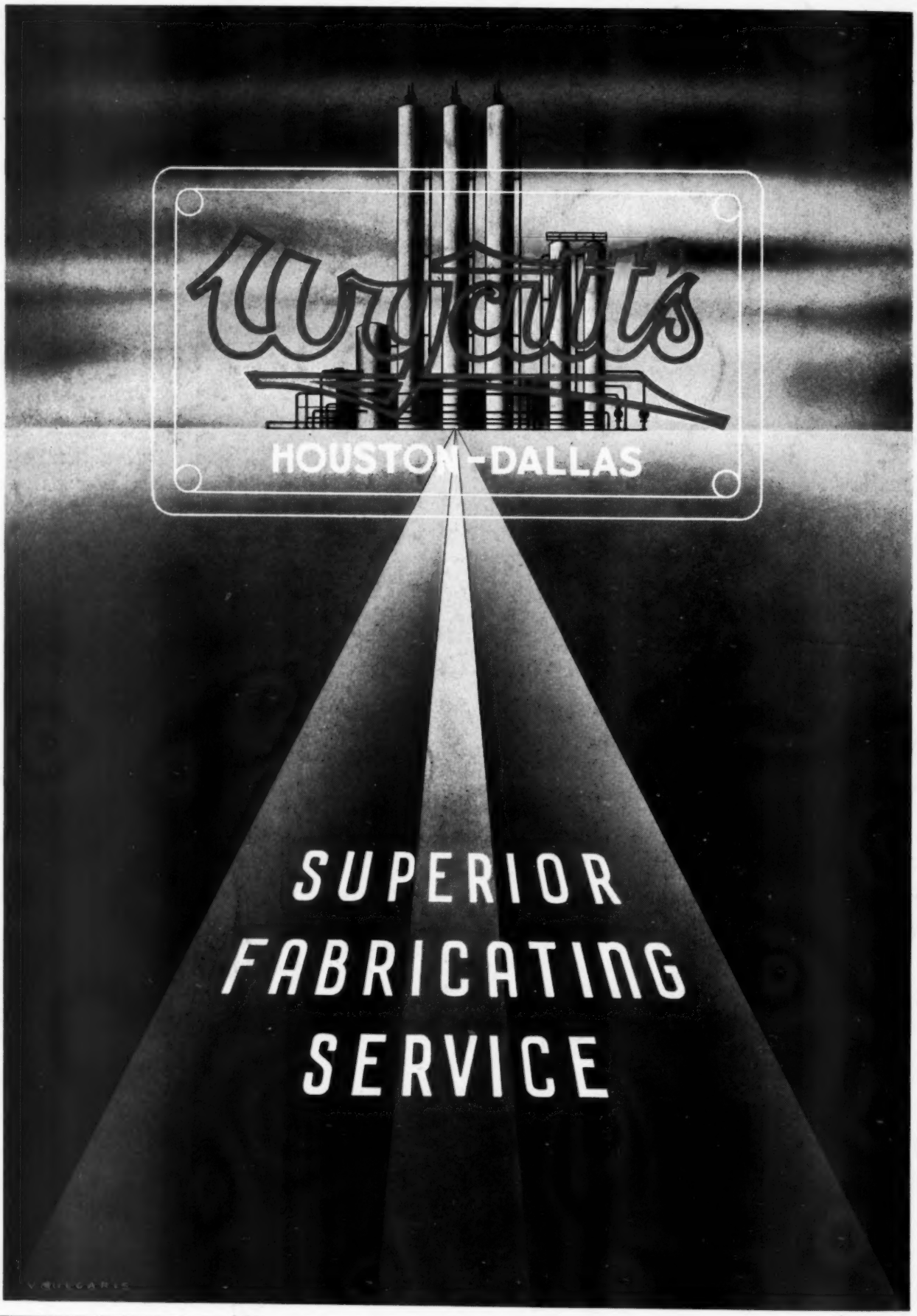

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